

Installation, Operation and Maintenance Manual

Centurion Water Heaters with Edge[®] [ii] Controller

Natural Gas and Propane Gas Modulating &
Condensing Water Heater

Models CEN 2000 & CEN 1600

WARNING: If the information in these instructions is not followed exactly, a fire or explosion may result causing property damage, personal injury, or death.

Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

Installation and service must be performed by a qualified installer, service agency or the gas supplier.



Disclaimer

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Manufacturing ASME Commercial Water Heaters Since 1961

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FOREWORD

The **PVI Centurion** modulating and condensing water heater represents a true industry advance to meet the needs of today's energy and environmental concerns. Designed for use with natural gas or propane gas in any closed loop hydronic system, the Centurion's modulating capability relates energy input directly to fluctuating system loads. Centurion models provide extremely high efficiency operation and are ideally suited for modern low temperature, as well as conventional, water heating systems.

Centurion Water Heater - Intake and Output Ranges				
MODEL	INPUT RANGE (BTU/HR.)		OUTPUT RANGE (BTU/HR.)	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
CEN 1600	100,000 (29.3 kW)	1,600,000 (470 kW)	90,000 (26.4 kW)	1,504,000 (441 kW)
CEN 2000	100,000 (29.3 kW)	2,000,000 (586 kW)	90,000 (26.4 kW)	1,920,000 (563 kW)

The output of Centurion Water Heaters is a function of the unit's firing rate (valve position) and return water temperature.

When installed and operated in accordance with this Instruction Manual, Centurion Water Heaters comply with the NOx emission standards outlined in: **South Coast Air Quality Management District (SCAQMD), Rule 1146.2.**

Whether used in singular or modular arrangements, Centurion Water Heaters offer the maximum venting flexibility with minimum installation space requirements. Centurion Water Heaters are Category II and IV, positive pressure appliances. Single and/or multiple breeched units are capable of operation in the following vent configurations:

- **Room Combustion Air: Vertical Discharge, Horizontal Discharge**
- **Ducted Combustion Air: Vertical Discharge, Horizontal Discharge**

The vent for this appliance must not be placed in the following locations:

- over public walkways
- near soffit vents or crawl space vents or other areas where condensate or vapor could create a nuisance or hazard or cause property damage
- where condensate vapor could cause damage or be detrimental to the operation of regulators, relief valves, or other equipment

See CSA/ANSI Z21.10.3:19, Figure 2-A and 2-B for vent terminal clearances.

Centurion Water Heaters are capable of being vented utilizing PVC, CPVC, Polypropylene and AL29-4C vent systems.

The advanced electronics in Centurion Water heaters are available in several selectable modes of operation, offering the most efficient operating methods and energy management system integration.

Technical Terminology Meanings	
A (Amp)	Ampere
ADDR	Address
AGND	Analog Ground
ALRM	Alarm
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
AUX	Auxiliary
BAS	Building Automation System, often used interchangeably with EMS
Baud Rate	Symbol rate, or the number of distinct symbol changes (signaling events) transmitted per second. It is not equal to bits per second, unless each symbol is 1 bit long.
BLDG (Bldg)	Building
BTU	British Thermal Unit; heat required to raise 1 pound (0.45 kg) of water 1°F (0.55 °C)
BTU/HR	BTUs per Hour (1 BTU/hr. = 0.29 W)
CCS	Combination Control System
CFH	Cubic Feet per Hour (1 CFH = 0.028 m ³ /hr.)
CO	Carbon Monoxide
COMM	Communication
Cal.	Calibration
CNTL	Control
CPU	Central Processing Unit
DBB	Double Block and Bleed, a gas trains containing 2 Safety Shutoff Valves (SSOVs) and a solenoid operated vent valve.
DHW	Domestic Hot Water
DIP	Dual In-Line Package, a type of switch
ECU	Electronic Control Unit (O ₂ sensor)
Edge Controller	A control system currently used in all Centurion Water Heaters.
EMS	Energy Management System; often used interchangeably with BAS
FM	Factory Mutual. Used to define Water Heater gas trains.
GF-xxxx	Gas Fired (a document numbering system)
GND	Ground
HDR	Header
Hex	Hexadecimal Number (0 – 9, A – F)
HP	Horsepower
HX	Heat Exchanger
Hz	Hertz (Cycles Per Second)
I.D.	Inside Diameter
IGN	Ignition
IGST Board	Ignition/Stepper Board contained in Edge Controller
INTLK (INTL'K)	Interlock
I/O	Input/Output
I/O Box	Input/Output (I/O) Box currently used on Centurion Water Heaters
IP	Internet Protocol
ISO	International Organization for Standardization
Lbs.	Pounds (1 lb. = 0.45 kg)
LED	Light Emitting Diode
LN	Low Nitrogen Oxide
MA (mA)	Milliampere (0.001)

Technical Terminology Meanings	
MBH	1000 BTUs per Hour
Modbus®	A serial, half-duplex data transmission protocol developed by AEG Modicon
NC (N.C.)	Normally Closed
NO (N.O.)	Normally Open
NOx	Nitrogen Oxide
NPT	National Pipe Thread
O ₂	Oxygen
O.D.	Outside Diameter
OMM, O&M	Operation and Maintenance Manual
Predictive Maintenance	An on-line remote monitoring system
PCB	Printed Circuit Board
PMC Board	Primary Micro-Controller (PMC) board, contained in the Edge
P/N	Part Number
POC	Proof of Closure
PPM	Parts per Million
PSI	Pounds per Square Inch (1 PSI = 6.89 kPa)
PTP	Point-to-Point (usually over RS232 networks)
P&T	Pressure and Temperature
ProtoNode	Hardware interface between BAS and a Water Heater
PVC	Poly Vinyl Chloride, a common synthetic plastic
PWM	Pulse Width Modulation
REF (Ref)	Reference
RES.	Resistive
RS232 (EIA-232)	A standard for serial, full-duplex (FDX) data transmission based on RS232 Standard
RS485 (EIA-485)	A standard for serial, half-duplex (HDX) based on the RS485 Standard
RTN (Rtn)	Return
SETPT (Setpt)	Setpoint Temperature
SHLD (Shld)	Shield
SPDT	Single Pole Double Throw, a type of switch
SSOV	Safety Shut-Off Valve
TAC	Turndown Adjustment Control
TEMP (Temp)	Temperature
Terminating Resistor	A resistor placed at each end of a daisy-chain or multi-drop network in order to prevent reflections that may cause invalid data in the communication
Tip-N-Tell	A device that indicates if a package was tipped during shipping
UL	A business that tests and validates products
VAC	Volts, Alternating Current
VDC	Volts, Direct Current
VFD	Variable Frequency Drive
VPS	Valve Proving System
W	Watt
WHM	Water Heater Management system
W.C.	Water Column, a unit of pressure (1 W.C. = 249 Pa)
µA	Micro amp (1 million th of an ampere)

SECTION 1: SAFETY PRECAUTIONS

1.1 Warnings & Cautions

Installers and operating personnel **MUST** observe all safety regulations at all times. 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 Instruction Manual, the installation of units **MUST** conform with local building codes, or, in the absence of local codes, ANSI Z223.1 (National Fuel Gas Code Publication No. NFPA-54) for gas-fired Water Heaters and ANSI/NFPA-58 for LP gas-fired Water Heaters.

Where applicable, the equipment shall be installed in accordance with the current Installation Code for Gas Burning Appliances and Equipment, CSA B149.1, 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.

See section 1.4 for important information regarding installation of units within the Commonwealth of Massachusetts.

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!

Do not use matches, candles, flames, or other sources of ignition to check for gas leaks.

Fluids under pressure may cause injury to personnel or damage to equipment when released. Be sure to shut off all incoming and outgoing water shutoff valves. Carefully decrease all trapped pressures to zero before performing maintenance.

Before attempting to perform any maintenance on the unit, shut off all gas and electrical inputs to the unit.

The exhaust vent pipe of the unit operates under a positive pressure and therefore must be completely sealed to prevent leakage of combustion products into living spaces.

Electrical voltages of 208 VAC, 480 VAC, 120 VAC and 24 volts AC, 24 VDC, 12 VDC may be used in this equipment. Therefore, the cover on the unit's power box (located behind the front panel door) must be installed at all times, except during maintenance and servicing.

A three-pole switch must be installed on the electrical supply line of the unit. The switch must be installed in an easily accessible position to disconnect electrical service quickly and safely. Do not affix switch to unit sheet metal enclosures.

CAUTION!

The appliance and all gas connections must be leak-tested before operation.

Many soaps used for gas pipe leak testing are corrosive to metals. The piping must be rinsed thoroughly with clean water after leak checks have been completed.

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

1.2 Emergency Shutdown

If overheating occurs or the gas supply fails to shut off, close the manual shutoff valve (Figure 1-1) on the outside of the unit.

NOTE: The Installer must identify and indicate the location of the emergency shutdown manual gas valve to operating personnel.



Figure 1-1: External Manual Gas Shutoff Valve

In addition, to ensure safety, an emergency shutdown procedure that addresses the following points should be designed and implemented:

- For automatically operated unattended units located in a Water Heater room, provide a manually operated remote shutdown switch or circuit breaker located just inside or outside each Water Heater room door. Design the system so activation of the emergency shutdown switch or circuit breaker will immediately shut off fuel to the unit(s).
- For automatically operated unattended Water Heaters in a location other than a Water Heater room, provide a readily accessible manually operated remote shutdown switch or circuit breaker, marked for easy identification at a location in the event of Water Heater mis-operation. Design the system so activation of the emergency shutdown switch or circuit breaker will immediately shut off fuel to the unit(s).
- For Water Heaters 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 fuel upon activation.

1.3 Prolonged Shutdown

If there is an emergency, turn the electrical power supply to the Water Heater to **OFF** and close the manual gas valve located upstream from the unit. The installer must identify the emergency shut-off device.

If the unit is being shut down one year or longer, complete the instructions in section 7.9.

When returning a unit to service after prolonged shutdown, follow the instructions in Sections 6 and 7 to verify that all system-operating parameters are correct.

1.4 Important – Requirements for Massachusetts Installations

.....[Extracted Information From 248 CMR 5.08 (2)].....

Installations within the Commonwealth of Massachusetts must conform to the following requirements:

- Water Heater must be installed by a plumber or a gas fitter licensed within the Commonwealth of Massachusetts.
- Prior to operation, the complete gas train and all connections must be leak tested using a non-corrosive soap.
- The vent termination must be located a minimum of 4 feet above grade level. If side-wall venting is used, the installation must conform to the following requirements **extracted from 248 CMR 5.08 (2)**:

(a) For all side wall horizontally vented gas fueled equipment installed in every dwelling, building or structure used in whole or in part for residential purposes, including those owned or operated by the Commonwealth and where the side wall exhaust vent termination is less than seven (7) feet above finished grade in the area of the venting, including but not limited to decks and porches, the following requirements shall be satisfied:

1. INSTALLATION OF CARBON MONOXIDE DETECTORS: At the time of installation of the side wall horizontal vented gas fueled equipment, the installing plumber or gasfitter shall observe that a hard-wired carbon monoxide detector with alarm and battery back-up is installed on the floor level where the gas equipment is to be installed. In addition, the installing plumber or gasfitter shall observe that a battery operated or hard-wired carbon monoxide detector with alarm is installed on each additional level of the dwelling, building or structure served by the side wall horizontal vented gas fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified licensed professionals for the installation of hard-wired carbon monoxide detectors.

a. In the event the side wall horizontally vented gas fueled equipment is installed in a crawl space or attic the hard-wired carbon monoxide detector with alarm and battery back-up may be installed on the next adjacent floor.

b. In the event that the requirements of this subdivision cannot be met at the time of completion of installation, the owner shall have a period of thirty (30) days to comply with the above requirements; provided, however, that during said thirty (30) day period, a battery-operated carbon monoxide detector with an alarm shall be installed.

2. APPROVED CARBON MONOXIDE DETECTORS: Each carbon monoxide detector as required in accordance with the above provisions shall comply with NFPA 720 and be ANSI/UL 2034 listed and IAS certified.

3. SIGNAGE: A metal or plastic identification plate shall be permanently mounted to the exterior of the building at a minimum height of eight (8) feet above grade directly in line with the exhaust vent terminal for the horizontally vented gas fueled heating appliance or equipment. The sign shall read, in print size no less than one-half (1/2) inch in size, "**GAS VENT DIRECTLY BELOW. KEEP CLEAR OF ALL OBSTRUCTIONS**".

4. INSPECTION: The state or local gas inspector of the side wall horizontally vented gas fueled equipment shall not approve the installation unless, upon inspection, the inspector observes carbon monoxide detectors and signage installed in accordance with the provisions of 248 CMR 5.08(2)(a)1 through 4.

(b) **EXEMPTIONS:** The following equipment is exempt from 248 CMR 5.08(2)(a)1 through 4:

1. The equipment listed in Section 10 entitled "Equipment Not Required to Be Vented" in the most current edition of NFPA 54 as adopted by the Board; and
2. Product Approved side wall horizontally vented gas fueled equipment installed in a room or structure separate from the dwelling, building or structure used in whole or in part for residential purposes.

(c) **MANUFACTURER REQUIREMENTS - GAS EQUIPMENT VENTING SYSTEM PROVIDED.** When the manufacturer of Product Approved side wall horizontally vented gas equipment provides a venting system design or venting system components with the equipment, the instructions provided by the manufacturer for installation of the equipment and the venting system shall include:

1. Detailed instructions for the installation of the venting system design or the venting system components; and
2. A complete parts list for the venting system design or venting system.

(d) **MANUFACTURER REQUIREMENTS - GAS EQUIPMENT VENTING SYSTEM NOT PROVIDED.** When the manufacturer of a Product Approved side wall horizontally vented gas fueled equipment does not provide the parts for venting the flue gases, but identifies "special venting systems", the following requirements shall be satisfied by the manufacturer:

1. The referenced "special venting system" instructions shall be included with the appliance or equipment installation instructions; and
2. The "special venting systems" shall be Product Approved by the Board, and the instructions for that system shall include a parts list and detailed installation instructions.

(e) A copy of all installation instructions for all Product Approved side wall horizontally vented gas fueled equipment, all venting instructions, all parts lists for venting instructions, and/or all venting design instructions shall remain with the appliance or equipment at the completion of the installation.

.....[End of Extracted Information From 248 CMR 5.08 (2)].....

SECTION 2: INSTALLATION

2.1 Receiving The Unit

Each Centurion Water Heater is shipped as a single, crated unit. The shipping weight for the Centurion is approximately 1,850 lbs. (839 kg).

The unit must be moved with proper rigging equipment for safety and to avoid 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, the unit must be moved by jack or forklift from the front only.

NOTE: PVI 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 The Unit

Carefully unpack the unit taking care not to damage the unit enclosure when cutting away packaging materials

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:

- ASME Temperature and Pressure Safety Relief Valve (P/N **92065-5**)
- An 8" Side Air Inlet Adapter (P/N **39184-1**)
- Condensate Drain Trap (P/N **24441**)
- CEN 2000: 2" Natural Gas Supply Valve (P/N **123540**)
- CEN 1600: 1 ½" Natural Gas Supply Valve (P/N **92006-7**)
- CEN 1600/2000 Propane: 1 ½" Propane Gas Supply Valve (P/N **92006-7**)

When optional accessories are ordered, they may be packed in 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 Site Preparation

Ensure that the site selected for installation of the unit includes:

- A level concrete "housekeeping" pad, per the requirements in Section 2.3.3;
- Access to a natural gas or propane gas supply as specified in Section 2.8;
- Access to AC input power specified in Section 2.9.

2.3.1 Installation Clearances

The unit must be installed with the prescribed clearances for service as shown in Figure 2-1. The minimum required clearance dimensions are listed below for all models. If Local Building Codes require additional clearances, those codes shall take precedence.

The **minimum acceptable clearances** required are as follows:

Front: 24 inches (61 cm)

Rear: 24 inches (61 cm)

Sides: 24 inches (61 cm)

Top: 18 inches (45.7 cm)

All gas piping, 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.

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: Centurion units may be installed with zero side clearances in pairs only. Perimeter clearances still apply. See drawings in *Appendix A: Dimensions and Clearance Drawings*.

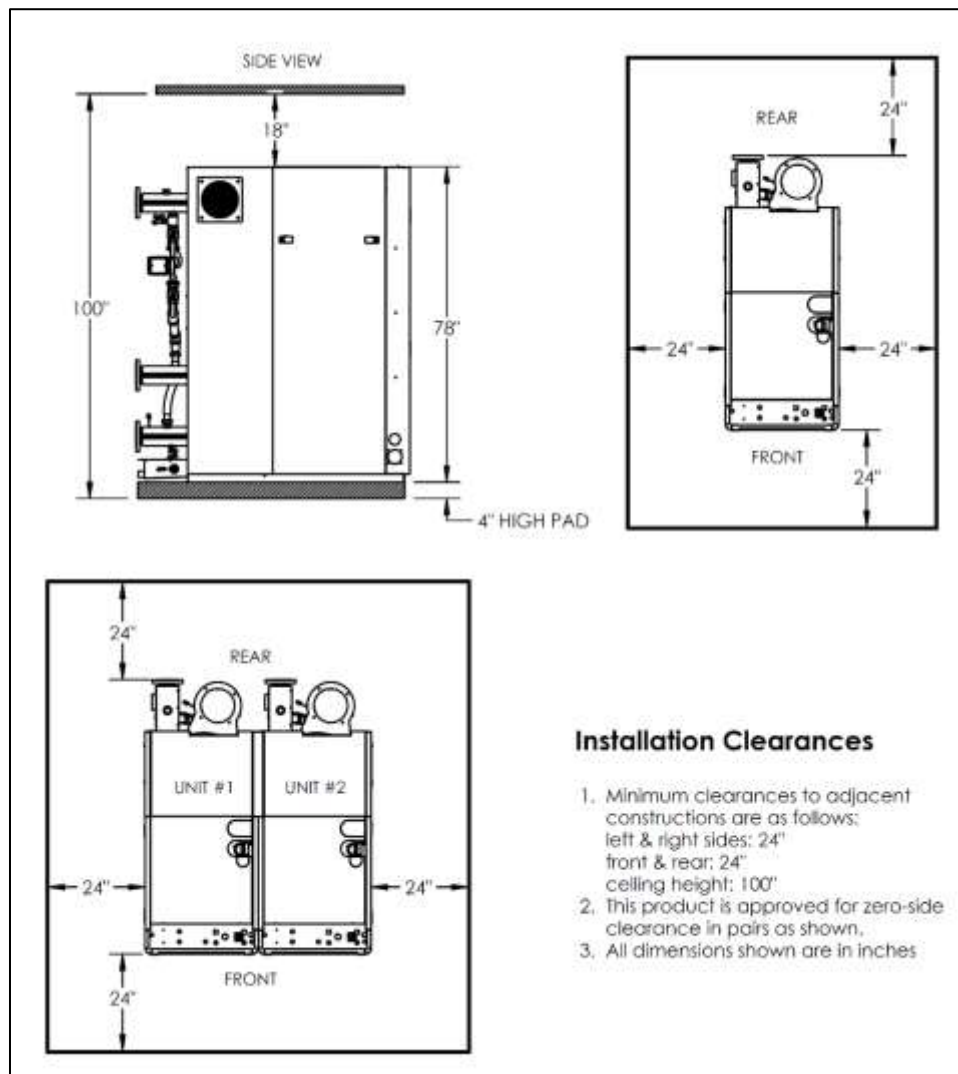


Figure 2-1: Clearances

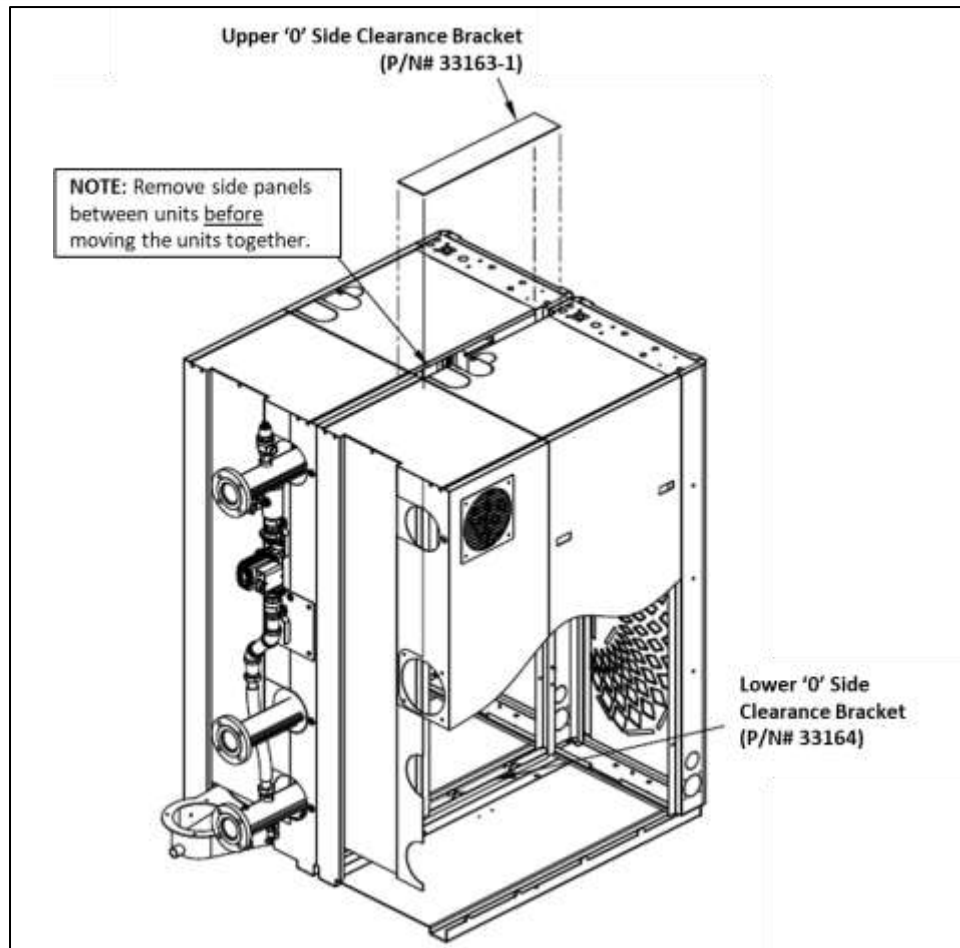


Figure 2-2: Centurion Zero-Side Clearance Kit (P/N# 58079-1)

⚠ WARNING!

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

FOR MASSACHUSETTS ONLY:

For Massachusetts installations, the unit must be installed by a plumber or gas-fitter licensed within the Commonwealth of Massachusetts. In addition, the installation must comply with all requirements specified in Section 1.4, above.

2.3.2 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 [millimeters]

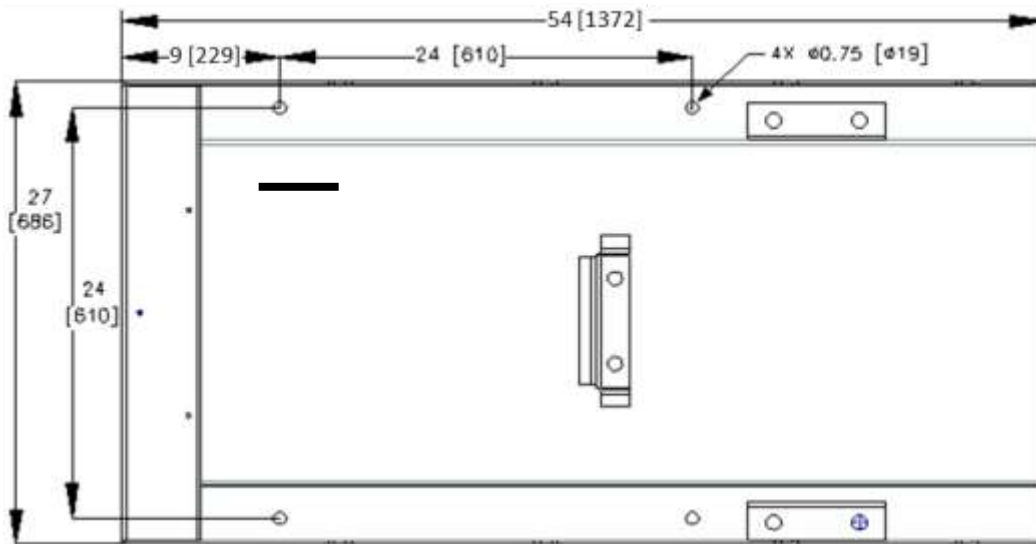


Figure 2-3: Anchor Bolt Locations

2.3.3 Housekeeping Pad Requirements

To ensure proper condensate drainage, the unit must be installed on a level concrete “housekeeping” pad. The unit must be positioned on the pad such that the condensate assembly is not located over the pad, as shown below.

The minimum thickness of the concrete pad depends on two factors:

- Which Centurion model you’re installing
- Whether the unit will connect to a Condensate Neutralizer tank.

The minimum pad thickness for installations without a Condensate Neutralizer tank is **4 to 8 inches** (10.2 to 20.3 cm)

If you are using the Condensate Neutralizer Tank (P/N **89030C**), you must ensure enough height for the condensate to drain into the condensate trap, then into the neutralizer tank, and then to the drain. This may require that a pit be dug for the Neutralizer Tank. For more information on the Condensate Neutralizer Tank, see Technical Instruction Document TID-0074.

The following table specifies the minimum pit depth for the Condensate Neutralizer Tank (P/N **89030C**) if the unit is installed on a **4” pad**, and the pad height if the Neutralizer Tank must be installed on the floor; note, in all cases a **6” pad** eliminates the need to a pit.

Pad Height Requirement with Neutralizer Tank	
Minimum Pit Depth	Pad Height Without Pit
1-1/4”	5-1/4”

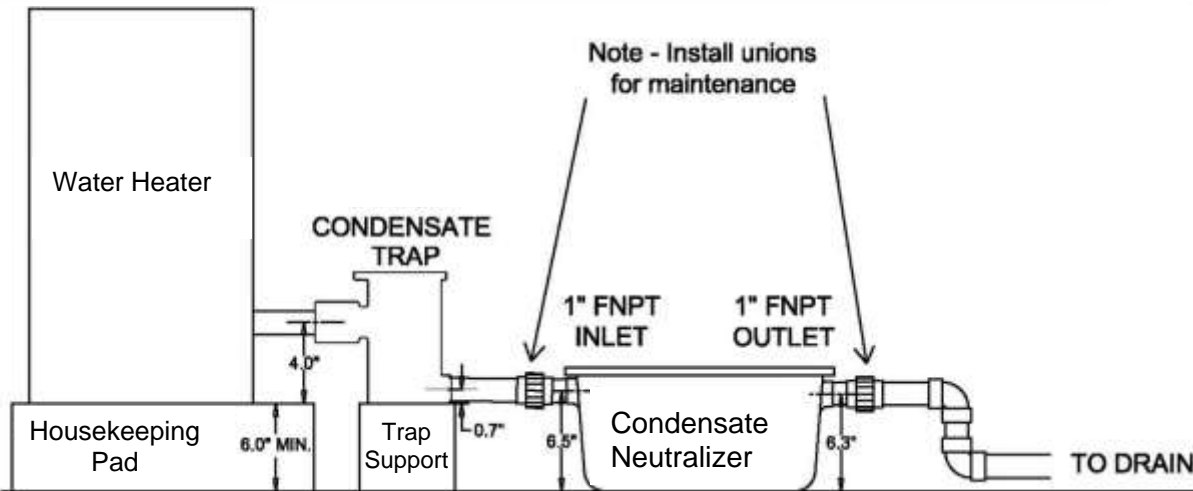


Figure 2-4: Condensate Neutralizer Tank Installation

2.4 Lifting Provisions

⚠ WARNING!

DO NOT attempt to lift or move Water Heater using the gas train or blower.

Three lifting lugs are attached to the top of the heat exchanger, as shown below. Remove the front and rear top panels from the unit to access the lifting lugs. Remove the four (4) lag screws securing the unit to the shipping skid. Lift the unit off the shipping skid and position it on the (required) concrete "housekeeping" pad.

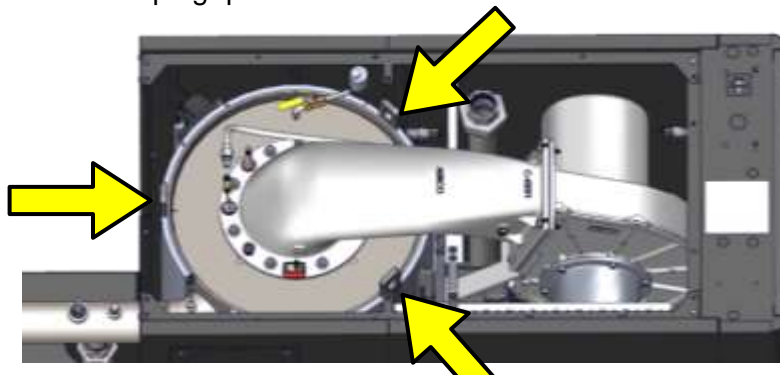


Figure 2-5: Water Heater Lifting Lug Locations

2.5 Piping Connections

Make sure the mating surfaces are thoroughly clean, before connecting the hot water outlet and return-water inlets to building piping.

Centurion Water Heaters have the following inlets and outlets:

- 3" (7.6 cm) flange water INLET and hot water OUTLET piping.
- One of the following gas inlet pipes:
 - 2" NPT Natural Gas inlet pipe (CEN 2000)
 - 1 ½" NPT Natural Gas inlet pipe (CEN 1600)
 - 1 ½" NPT Propane Gas inlet pipe (CEN1600/2000)
- 8" (20.3 cm) Air Inlet adapter.

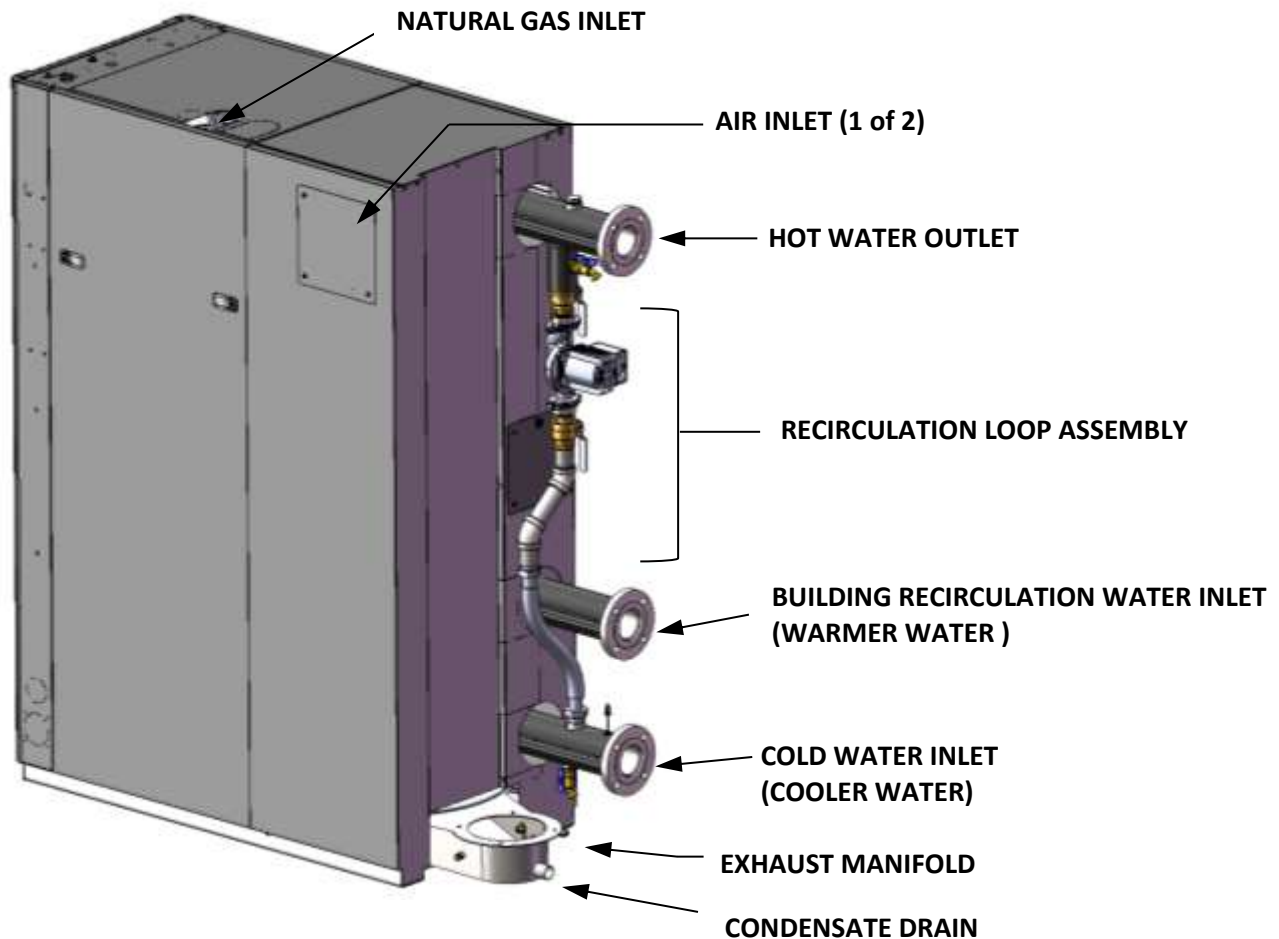


Figure 2-6: Inlet and Outlet Locations

2.5.1 Internal Recirculation Water Loop

The internal Recirculation Water Loop assembly is located at the rear of the unit (Figure 2-6).

This assembly contains a recirculation pump that connects the upper hot water outlet to the lower (cold) water inlet to heat exchanger. This loop provides feed-forward (FFWD) temperature control by mixing a portion of the hot water outlet with the cold-water inlet to the unit.

Temperature sensors located in the hot water outlet and the lower cold-water inlet provide temperature data to the Edge Controller. The Controller utilizes this data to modulate the fire rate (Air/Fuel Valve position) to precisely maintain the hot water outlet temperature at the selected setpoint temperature. A check valve integrated into the pump prevents the water flow from the cold water inlet side to the hot water outlet side through the recirculation loop.

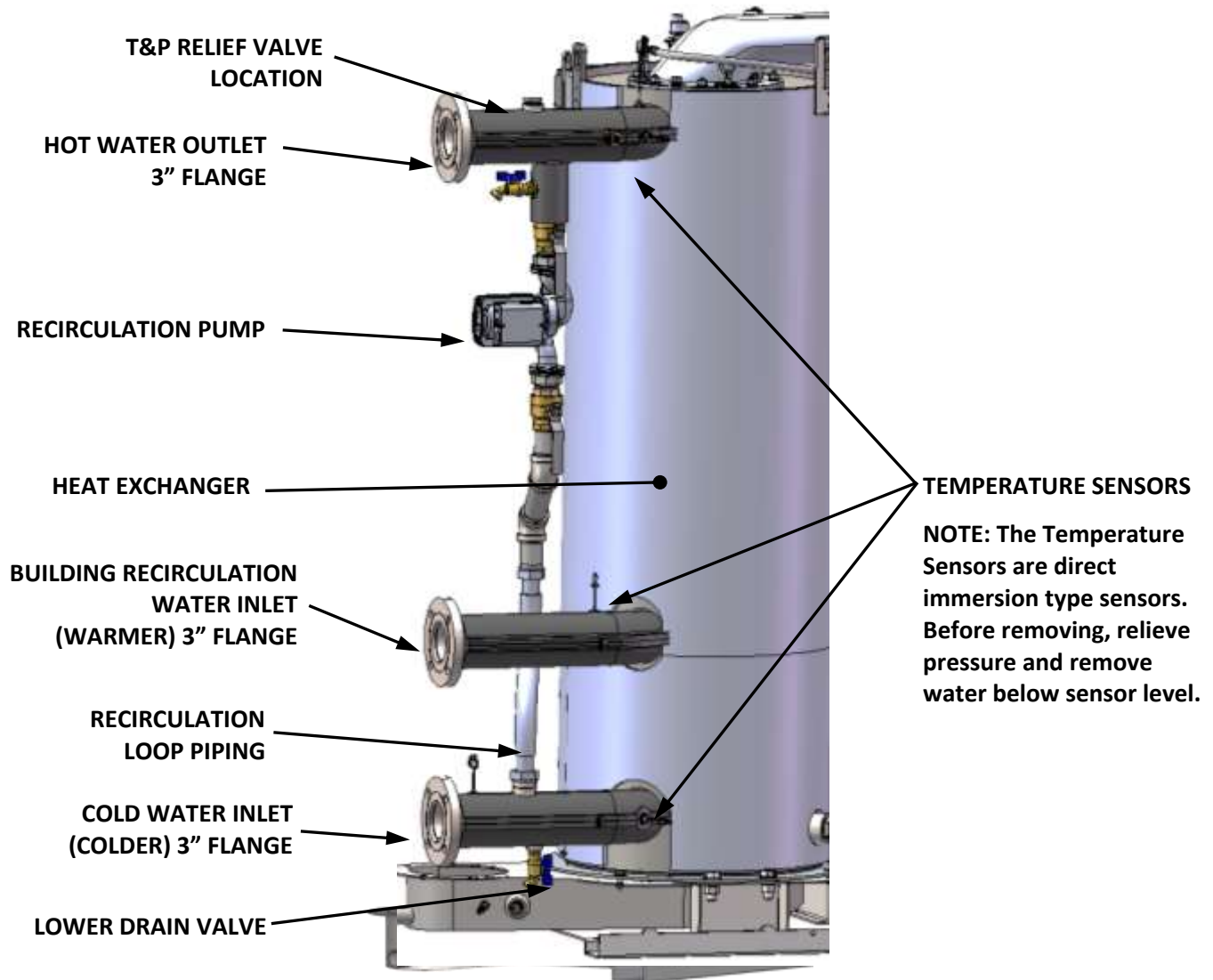


Figure 2-7: Recirculation Loop Rear View

2.5.2 Test Hose Connection

A test hose must be connected from the drain valve on the hot water outlet to the floor drain. This is **required** for startup and testing. The test hose diameter should be a minimum of 3/4" (1.9 cm).

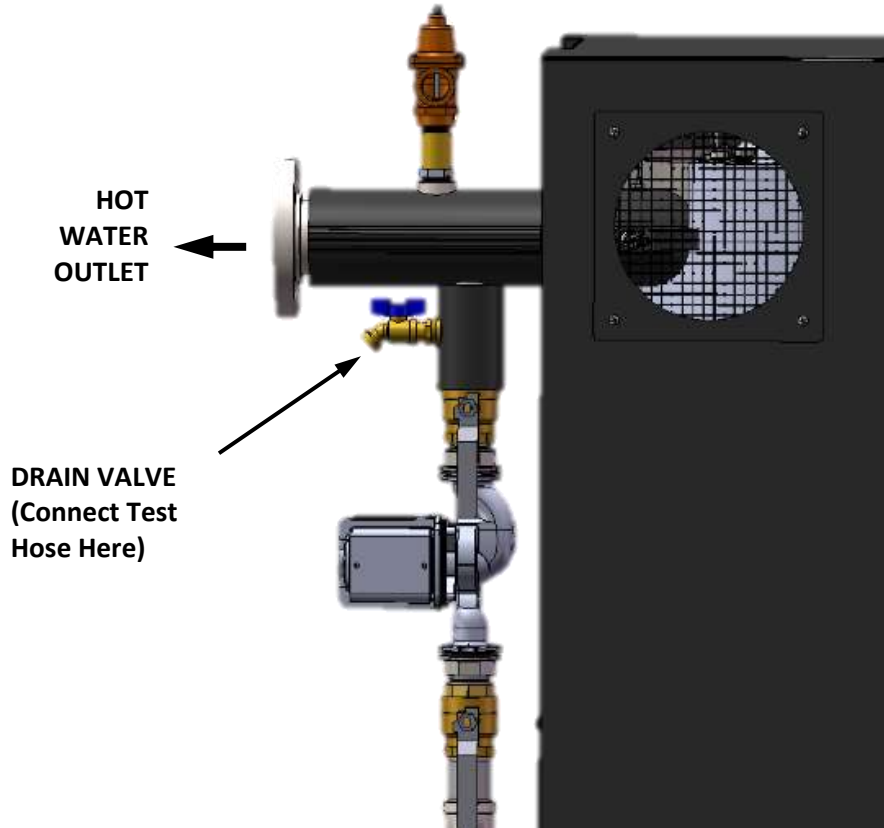


Figure 2-8: Test Hose Location

2.5.3 Dual Inlet Return Piping

The standard dual-inlet connections allow Centurion Water Heaters to be configured with a separate cooler return temperature zone, rather than blending high and low return temperature zones. Utilizing the dual return capability, these Water Heaters can take further advantage of the unit's condensing capabilities. When configured in this way, thermal efficiency can improve by up to 6% (based on an 80 °F (26.7 °C) minimum return water temperature at full fire).

To use the recirculation inlet, pipe the warmer building return water to the building recirculation (upper) inlet and the cold domestic inlet water to the lower inlet.

Contact your PVI representative for additional information.

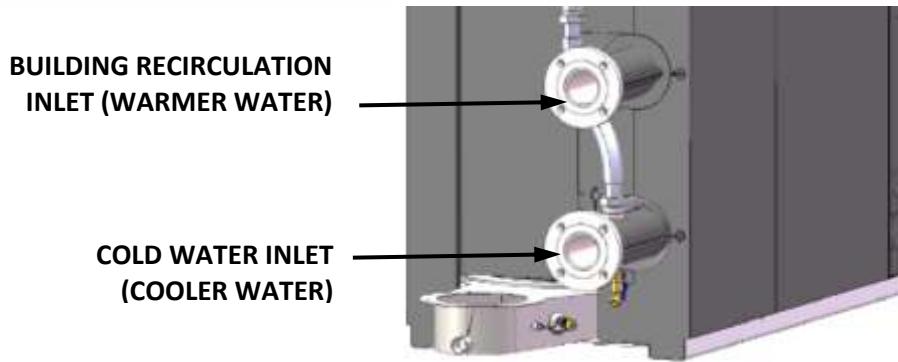


Figure 2-9: Dual Inlets

2.5.4 Sequencing Isolation Valve

Centurion Water Heaters with Water Heater Management (WHM) will arrive with the actuator-controlled Sequencing Isolation Valve, packed separately within the shipping container.

If installation is required, see *Section 2.13: Sequencing Isolation Valve Installation*. See *Section 5.2.4: Recommendations for WHM Operation* and *SECTION 8: Water Heater Management* for more information on implementing WHM.

NOTE: Sequencing Isolation Valves are required in a multi-unit configuration.

2.6 Temperature and Pressure Relief Valve Installation

An ASME rated Temperature and Pressure Relief Valve is supplied with each Centurion Water Heater. The valve setpoint is 150 psig (1034 kPa) at 210°F (98.9°C). The relief valve is installed on the hot water outlet of the Water Heater, as shown below. 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. No valve is allowed between the relief valve and the heat exchanger.

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.

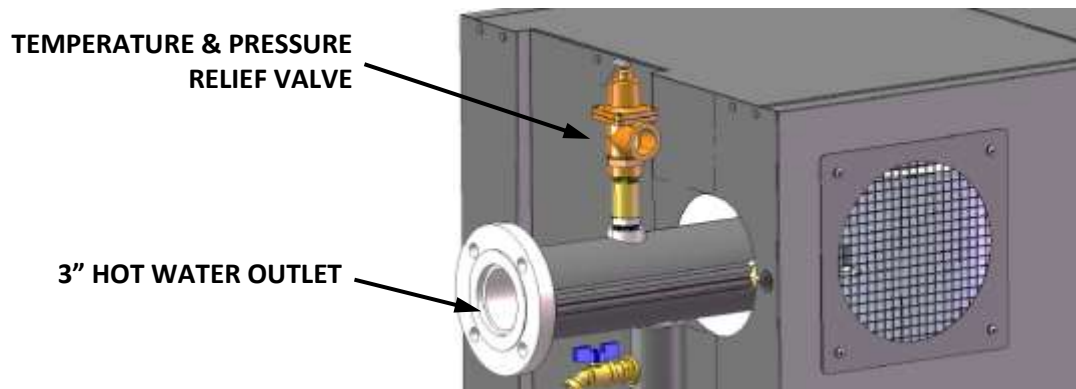


Figure 2-10: Temperature and Pressure Relief Valve Location

2.7 Condensate Drain and Piping

Centurion Water Heaters are designed to condense water vapor from the flue products. The installation must therefore have provisions for suitable condensate drainage or collection. See below for information on the condensate drain and piping for the various models.

The condensate drain port located on the exhaust manifold (see Figure 2-11) must be connected to the condensate trap (P/N **24441C**), which is packed separately within the unit's shipping container. Its inlet and outlet connections contain tapped 3/4" NPT ports.

A sample condensate trap installation is shown in Figure 2-11. However, the actual installation details for the trap will vary depending on the available clearances, housekeeping pad height/dimensions and other prevailing conditions at the site.

- NOTE:** The following guidelines must be observed to ensure proper condensate drainage:
- Condensate trap inlet must be level with or lower than the exhaust manifold drain port.
 - The base of the condensate trap must be supported to ensure that it is level (horizontal).
 - The trap must be removable for routine maintenance. PVI recommends that a union be utilized between the exhaust manifold condensate drain port and the trap inlet port.
 - If the condensate trap does not connect directly to the condensate drain port, the pipe between the drain and the trap must be stainless steel, PVC, polypropylene or aluminum.
 - The concrete housekeeping pad must not extend under the condensate assembly.

Condensate Drain Installation

1. Connect the condensate trap inlet to the exhaust manifold drain connection using the appropriate piping components (nipples, reducers, elbows, etc.).
2. At the condensate trap outlet, install a 3/4" NPT nipple.
3. Connect 1" (2.54 cm) I.D. polypropylene hose to trap outlet and secure with clamp.
4. Route the hose on the trap outlet to a condensate neutralizer tank.

⚠ WARNING!

Use PVC, stainless steel, aluminum, or polypropylene for condensate drain piping. Do **NOT** use carbon or copper components.

If a floor drain is not available, a condensate pump can be used to remove the condensate to an appropriate drain. The maximum condensate flow rate is **16 gallons (60 liters) per hour**.

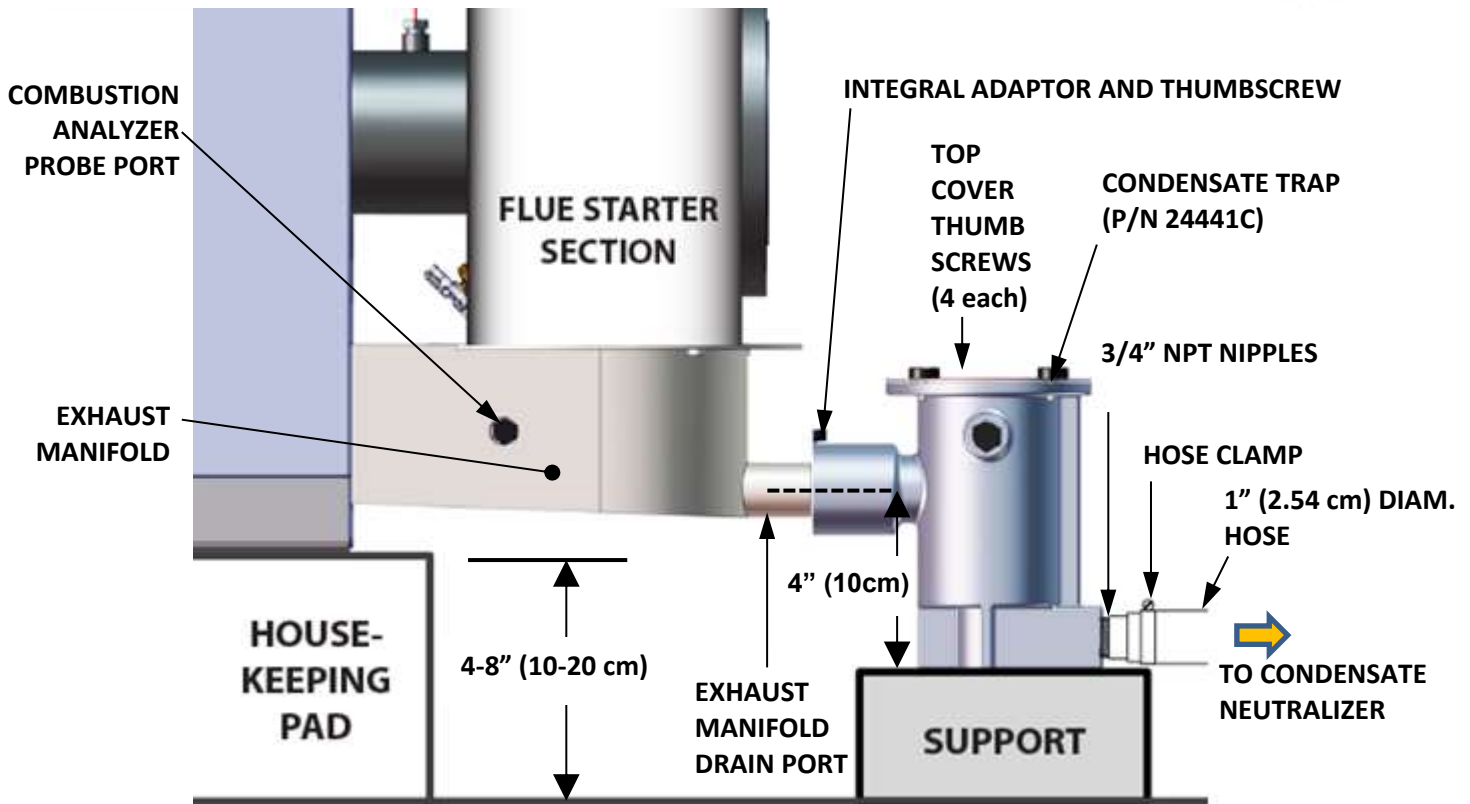


Figure 2-11: Sample Condensate Trap Installation

2.8 Gas Supply Piping

⚠ WARNING!

Never use matches, candles, flames, or other sources of ignition to check for gas leaks.

CAUTION!

Many of the soaps used for gas pipe leak testing are corrosive to metals. Therefore, piping must be rinsed thoroughly with clean water after leak checks have been completed.

NOTE: All gas piping must be arranged so that it does not inhibit removal of covers or service/maintenance or restrict access between the unit and walls or other units.

Model	NATURAL GAS Piping	PROPANE Gas Piping
CEN 2000	2 inch (5.1 cm) on top of unit	1 ½ inch (3.8 cm) on top of unit
CEN 1600	1 ½ inch (3.8 cm) on top of unit	1 ½ inch (3.8 cm) on top of unit

Prior to installation, all pipes should be de-burred and internally cleared of any scale, metal chips or other foreign particles. Do *NOT* install any flexible connectors or unapproved gas fittings. Piping must be supported from the floor, ceiling, or walls only, not by the unit.

A suitable piping compound, approved for use with natural gas, should be used. Any excess must be wiped off to prevent clogging of components.

To avoid unit damage when pressure testing gas piping, the unit must be isolated from the gas supply piping. A thorough leak test of all external piping must be performed using a soap and water solution or suitable equivalent. The gas piping used must meet all applicable codes.

2.8.1 Gas Supply Specifications

Centurion Water Heaters require a stable natural gas or propane input pressure that complies with the allowable gas inlet pressure range in the tables below:

CEN 2000/1600 Allowable NATURAL GAS Inlet Pressure for Standard and DBB Gas Trains		
	Minimum	Maximum
STANDARD GAS TRAINS	4.0" W.C. (1.00 kPa)	14.0" W.C. (3.49 kPa)
DBB GAS TRAINS	4.5" W.C. (1.12 kPa)	14.0" W.C. (3.49 kPa)

CEN 2000/1600 Allowable PROPANE Gas Inlet Pressure for Standard and DBB Gas Trains		
	Minimum	Maximum
STANDARD GAS TRAINS	8.0" W.C. (2.00 kPa)	14.0" W.C. (3.49 kPa)
DBB GAS TRAINS	8.0" W.C. (2.00 kPa)	14.0" W.C. (3.49 kPa)

Gas pressure must be measured when the unit is in operation at full fire. Measure the gas pressure with a manometer at the NPT ball valve provided at the SSOV inlet. In a multiple Water Heater installation, gas pressure must initially be set for single unit operation, and then the remaining units must be staged on at full fire, to ensure gas pressures never falls below the supply gas pressure when the single unit was firing.

All Centurion models have a low supply gas pressure switch in the gas train to prevent operation if incoming gas pressure is insufficient.

2.8.2 External Gas Supply Regulator

An external gas pressure regulator is required on the gas inlet piping under most conditions (see, below). Regulators must conform to the specifications in the following table:

CEN 2000/1600 Lock-Up Regulator Sizing		
	Required Volume	
	CFH	(m ³ /HR)
Natural Gas	2000 – 2300	(56.6 – 65.1)
Propane Gas	800 – 950	(22.6 – 26.9)

An external lock-up type regulator **MUST** be installed downstream of the isolation valve at all installations where gas supply pressure will exceed **14.0" W.C. (3.49 kPa)**.

CAUTION!

Centurion units must be isolated from the system when leak testing.

Drip legs are typically required at the gas supply of each unit to prevent any dirt, weld slag, or debris from entering the unit's gas train inlet pipe. When multiple units are installed, some utilities and local codes require a full-size drip leg on the main gas supply line in addition to the drip leg at each unit. The bottom of the gas drip leg(s) should be removable without disassembling any gas piping. The weight of the gas pipe must not be supported from the bottom of the drip leg. The drip leg(s) must not be used to support any or part of the gas piping.

NOTE: It is the responsibility of the customer to source and purchase the appropriate gas regulator as described above. However, PVI offers for sale an appropriate regulator, which may be ordered at the time of unit purchase or separately. Contact your PVI sales representative for more information.

On all Centurion models it is strongly recommended that the pressure regulator be installed a minimum distance of 10 pipe diameters between the pressure regulator and the nearest downstream fittings (an elbow or the unit itself), and a minimum of 5 pipe diameters between the pressure regulator and any upstream fitting, such as elbow or shutoff valve, as shown below.

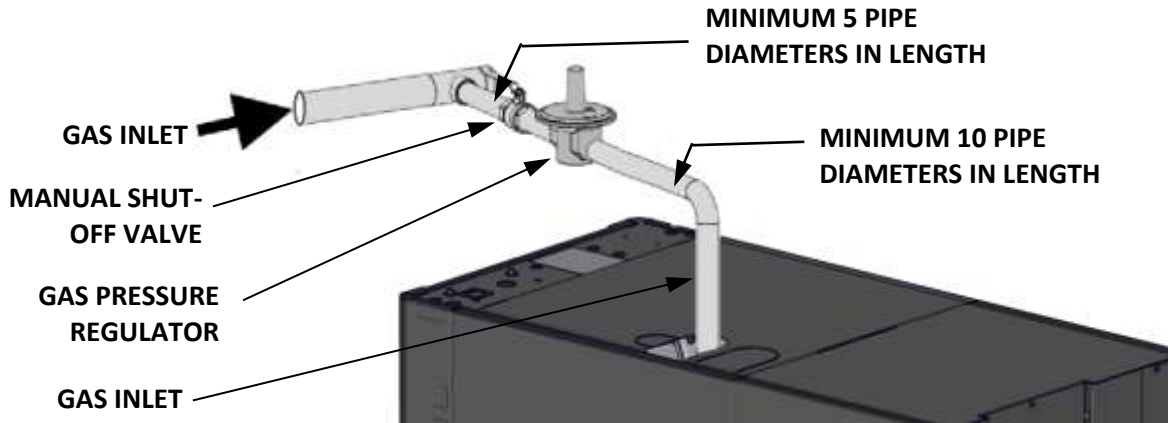


Figure 2-12: Gas Regulator and Manual Shut-Off Valve

2.8.3 Massachusetts Installations Only

For Massachusetts installations, a mandatory external gas supply regulator must be positioned as shown in Figure 2-12. The gas supply regulator must be properly vented outdoors.

2.8.4 Manual Gas Shutoff Valve

A manual shut-off valve must be installed in the gas line upstream from the unit, as shown.

2.9 AC Electrical Power Wiring

Centurion Water Heaters CEN 2000/1600 are available with the following power options:

Voltage	Phase	Amperage
208 V	3Ø / 60 Hz	20
460 V	3Ø / 60 Hz	15

2.9.1 Power Panel Locations

External AC power connection is made inside the Power Panel, located on the front of the unit, behind the unit's removable front panel.

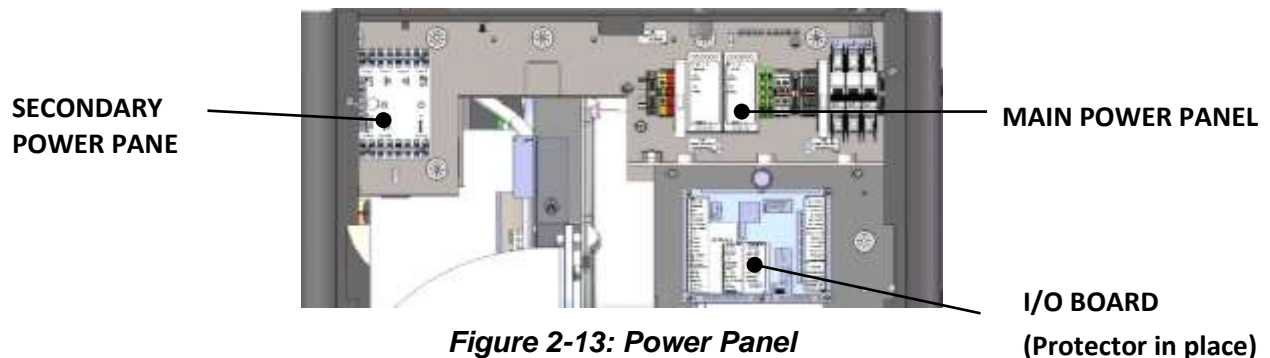


Figure 2-13: Power Panel

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

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

After placing the unit in service, the ignition safety shutoff device must be tested. If an external electrical power source is used, the installed Water Heater 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.

2.9.2 Electrical Power Panel Internal Components

Remove the front panel to access the main Power Panel. Run the electrical service through the opening above the Power Panel and make the connections to the Power Breaker in accordance with the Power Panel cover label.

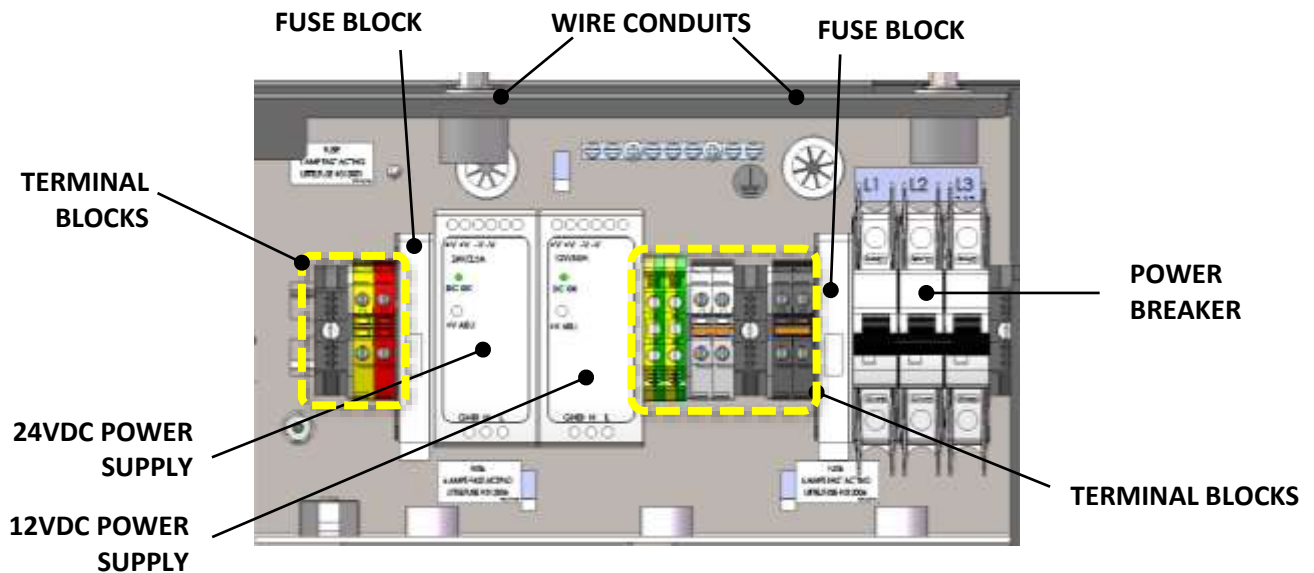


Figure 2-14: Electrical Power Panel Internal Components

NOTES:

The 115 VDC to 24 VDC transformer provides power to the Edge Controller, Condensate Block Sensor and the Sequencing Isolation Valve. It is mounted on rails inside the power box. All components in the Power Panel are mounted on a DIN rail on the panel.

The 115 V to 12 VDC transformer provides power to the IO Board and O₂ ECU module. Refer to APPENDIX B – *WIRING DIAGRAMS*.

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.

2.10 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 your Centurion unit does allow for some additional control and monitoring features. Wiring connections for

these features can be made on the Secondary Power Panel (see Figure 2-15) and the Input/Output (I/O) board located behind the unit's front panel (see Figure 2-16).

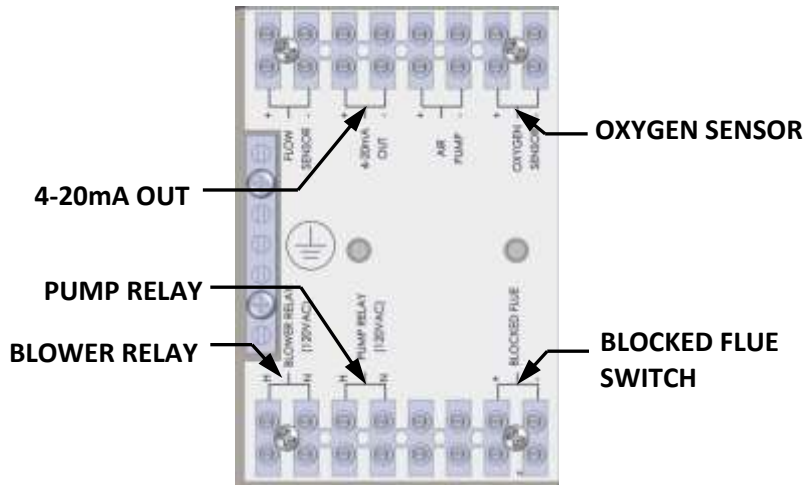


Figure 2-15: Secondary Power Panel Terminals

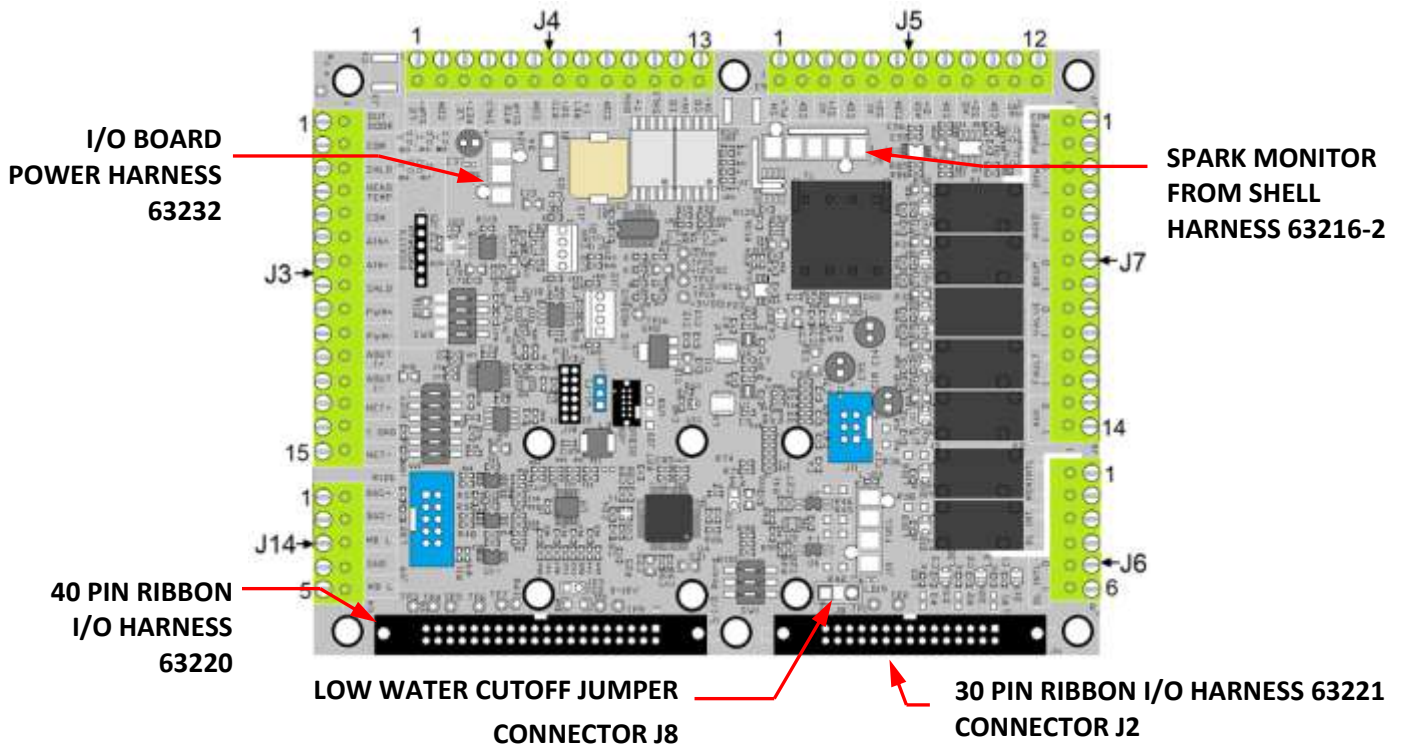
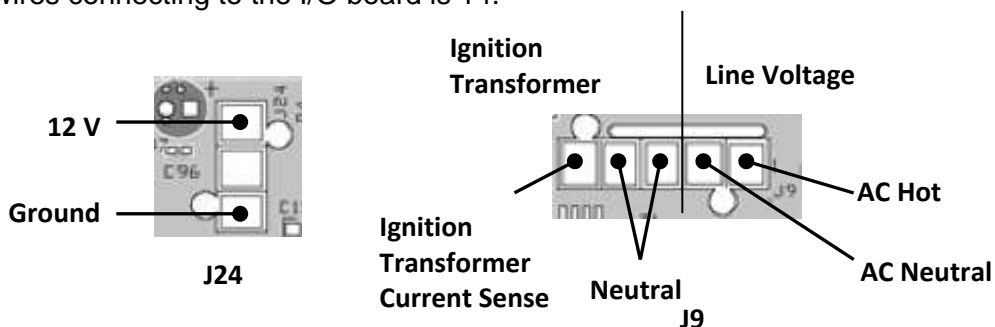


Figure 2-16: I/O Board Cable Connections

2.10.1 I/O Board Connections

The I/O board contains the terminals listed below, arranged on removable, named connector strips J3 through J7 and J14, plus Molex connectors for unit harnesses. The maximum gauge of wires connecting to the I/O board is 14.



NOTE: To facilitate connections these strips can be lifted off the I/O board, then remounted after all connections have been made. If a connector strip is removed, it must be re-mounted in its original orientation (connecting wires arranged around the **outside** perimeter of the I/O board).

Connector Strip J3 Terminals		
Pin #	Name	Description
1	Outside Temp +	Reserved for future use.
2	Outside Temp -	
3	Shield	Connection to the shield from any cable.
4	Supply Header +	Connection to the Supply Header temperature sensor (2 wire sensor P/N 24410C , or 4 wire sensor P/N 61058C) for: <ul style="list-style-type: none"> Solar/Waste Heat application Booster heat application Typically used on Manager and Backup Manager units.
5	Supply Header -	
6	Remote Analog In +	Connection to the Analog Remote Signal if Operating Mode = Remote Setpoint . Used on Manager and Backup Manager units.
7	Remote Analog In -	
8	Shield	Connection to the shield from any cable.
9	PWM Input +	Reserved for future use.
10	PWM Input -	
11	BLR V.S. Pump +	Reserved for future use. Water Heater Variable Speed Pump. Connection for the VFD signal to the pump,
12	BLR V.S. Pump -	
13	BST/WHM RS485 +	Dedicated to internal communication between units in WHM system. ACS (legacy) panel should also be connected to this terminal.
14	RS485 Iso Gnd	
15	BST/WHM RS485 -	

Connector Strip J4 Terminals		
Pin #	Name	Description
1	Supply Loop 2	In a multiple application configuration, connection to the 2 nd loop <u>supply</u> header temperature sensor.

Connector Strip J4 Terminals		
Pin #	Name	Description
2	Sensor Ground	Ground connection for Supply Loop 2
3	Return Loop 2	In a multiple application environment, connection to the 2 nd loop <u>return</u> header temperature sensor.
4	Shield	Connection to the shield from any cable.
5	RTD Spare 1	Reserved. Spare temp sensor
6	Sensor Ground	Ground connection for RTD Spare 1
7	RTD Spare 2	Reserved. Spare temp sensor
8	Return Header	Connection to the Supply Header temperature sensor (2 wire sensor P/N 24410C , or 4 wire sensor P/N 61058C) for: <ul style="list-style-type: none"> Solar/Waste Heat application Typically, used on Manager and Backup Manager units.
9	Sensor Ground	Ground connection for Return Header Temp sensor
10	DHW Temp	Connect the DHW tank temperature or DHW Loop Supply Temperature sensor
11	Shield	Connection to the shield from any cable.
12	CO/Analog In +	Reserved for future use
13	CO/Analog In -	

Connector Strip J5 Terminals		
Pin #	Name	Description
1	Spare Analog In 3 +	Connection to one of the following signals: <ul style="list-style-type: none"> Swing V1 feedback Swing V2 Feedback VS Pump Feedback (Variable Speed Pump Feedback) Remote Setpoint 2 DHW VSP Fdbk To assign/program its function, go to the Controller's Main Menu → Advanced Setup → Ancillary Devices → Analog Inputs, then set the Analog Input Source parameter to Spare Analog In 1, Spare Analog In 2, or Spare Analog In 3.
2	Spare Analog In 3 -	
3	Spare Analog In 1 +	
4	Spare Analog In 1 -	
5	Spare Analog In 2 +	
6	Spare Analog In 2 -	To assign/program its function, go to the Controller's Main Menu → Advanced Setup → Ancillary Devices → Analog Inputs, then set the Analog Input Source parameter to Spare Analog In 1, Spare Analog In 2, or Spare Analog In 3.
7	Spare Analog Out 1 +	Connection to one of the following signals: <ul style="list-style-type: none"> Fire Rate Cascade Valve To assign/program its function, go to the Controller's Main Menu → Advanced Setup → Ancillary Devices → Analog Outputs, then set the Select Output parameter to Spare Analog Out 1.
8	Spare Analog Out 1 -	
9	DHW V.S. Pump +	Recirc pump on the unit
10	DHW V.S. Pump -	
11	Spare Analog Out 3 +	Connection to the Fire Rate signal.
12	Spare Analog Out 3 -	To assign/program its function, go to the Controller's Main Menu → Advanced Setup → Ancillary Devices → Analog Outputs, then set the Select Output parameter to Spare Analog Out 3.

Connector Strip J6 Terminals		
Pin #	Name	Description
1	Remote Interlock Out	Connection to an auxiliary device interlock, such as louver open feedback or flow sensor.
2	Remote Interlock Return	
3	Delayed Interlock 1 Out	Connection to an auxiliary device interlock that requires a delay before the plant starts firing.
4	Delayed Interlock 1 Return	
5	Delayed Interlock 2 Out	Connection to an auxiliary device interlock that requires a delay before the plant starts firing.
6	Delayed Interlock 2 Return	

Connector Strip J7 Terminals		
Pin #	Name	Description
1	Spare 2 Relay N.O.	Connection to an auxiliary device enable/disable signal, such as: <ul style="list-style-type: none"> • System Pump • Pump 2 • Louver 2 • Summer Pump • Louver • Damper To assign/program its function, go to the Controller's Main Menu → Advanced Setup → Ancillary Devices → Relays , then set Select Relay to Spare 2 Relay and set Relay Name to one of the above devices.
2	Spare 2 Relay Com	
3	DHW Pump Relay N.O.	Tank Pump 2
4	DHW Pump Relay Com	
5	V2/Spare 1 Relay N.O.	Connection to an auxiliary device enable/disable signal, such as: <ul style="list-style-type: none"> • Tank Pump 2 • Summer Pump • Louver • System Pump • Pump 2 • Louver 2 To assign/program its function, go to Main Menu → Advanced Setup → Ancillary Devices → Relays, then set Select Relay to V2/Spare 1 Relay and set Relay Name to one of the above devices.
6	V2/Spare 1 Relay Com	
7	Reserve Relay N.O.	Connection to a reserve/backup Water Heater enable/disable signal.
8	Reserve Relay Com	
9	Swing Valve 1 Relay N.O.	Connection to a Swing Valve 1 enable/disable signal.
10	Swing Valve Relay Com	
11	Fault Relay N.O.	Connection to a Fault/Remote Alarm enable/disable signal.
12	Fault Relay Com	
13	Aux Relay N.O.	Connection to an auxiliary device enable/disable signal.
14	Aux Relay Com	

Connector Strip J14 Terminals		
Pin #	Name	Description
1	BAS RS485 +	Connection to the building automation system (BAS) network (Modbus RTU, BACnet MSTP). For IP network, use the Ethernet port.
2	BAS RS485 -	
3	RS485 Local +	Reserved for internal use only
4	RS485 Ground	
5	RS485 Local -	

2.11 Flue Gas Vent Installation

PVI's *Centurion Venting and Combustion Air Design Guide* should be consulted before any flue or combustion air venting is designed or installed. Suitable, U/L approved, positive pressure, watertight vent materials **MUST** be used for safety and UL certification.

1. Go to: **Main Menu → Advanced Setup → Unit → Unit Settings.**



Figure 2-17: Unit Settings Screen

2. Find the **Vent Type** parameter.
3. Set parameter to match your vent material: PVC, CPVC, Polypro or Stainless Steel. This sets the exhaust temperature limits. Note, PVC is not allowed in Massachusetts.

Because the unit is capable of discharging low temperature exhaust gases, **the flue must be pitched back towards the unit a minimum of 1/4" per foot (0.64 cm per 0.3 m)** to avoid any condensate pooling and to allow for proper drainage.

While there is a positive flue pressure during operation, the combined pressure drop of vent and combustion air systems **must not exceed 140 equivalent feet (42.7 m) or 0.8" W.C. (199 Pa)**. Fittings as well as pipe lengths must be calculated as part of the equivalent length. For a natural draft installation, **the draft must not exceed -0.25" W.C. (-62 Pa)**. These factors must be planned into the vent installation. If the maximum allowable equivalent lengths of piping are exceeded, the unit will not operate properly or reliably.

2.11.1 Installing the Exhaust Connection for PVC/CPVC (P/N 24786)

Align the 8" exhaust starter piece (P/N 24786) with the holes on the exhaust manifold of the unit. Fasten the starter piece to the exhaust manifold using the four (4) washers and bolts supplied with the unit. Insert the PVC stack into the starter piece and fasten with the three supplied screws evenly spaced 120 degrees apart, as shown below. Apply a bead of high temperature RTV around the top rim of the starter piece to create a seal between the starter piece and PVC.

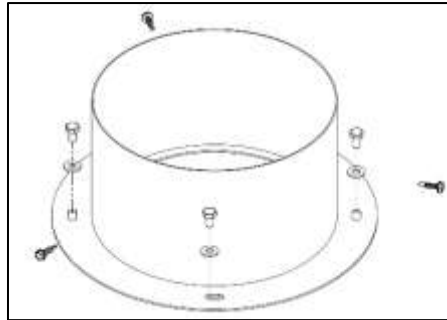


Figure 2-18: Fasten the Three Screws 120 Degrees Apart

2.11.2 Massachusetts Installations

For Massachusetts installations, the following companies provide vent systems that conform to all applicable requirements for installations within the Commonwealth of Massachusetts:

Selkirk Corporation - Heatfab Division 130 Industrial Blvd. Turners Falls, MA 01376 Phone: 1-800-772-0739 www.heatfab.com	Watertown Supply 33 Grove St. Watertown, MA 02472 Phone: (617) 924-2840 www.watertownsupply.com
Glover Sheet Metal, Inc. 44 Riverdale Ave. Newton, MA 02485 Phone: (617) 527-8178 www.gloversheetmetal.com	Emerson Swan Co 300 Pond St. Randolph, MA 02368 Phone 781-986-2555 www.emersonswan.com

2.12 Combustion Air

The *Centurion Venting and Combustion Air Design Guide*, TAG-0102 **must** be consulted before any inlet air venting is designed or installed. Air supply is a direct requirement of ANSI 223.1, NFPA-54, CSA B149.1 and local codes. These codes should be consulted before a permanent design is determined.

The combustion air must be free of chlorine, halogenated hydrocarbons, other chemicals that can become hazardous when used in gas-fired equipment and other combustion products. Common sources of these compounds are swimming pools, degreasing compounds, brine tanks, plastic processing, and refrigerants. Whenever the environment contains these types of chemicals, combustion air **MUST** be supplied from a clean area outdoors for the protection and longevity of the equipment and warranty validation.

If combustion air is supplied directly to the unit(s) through air duct(s), see Section 2.12.1, below.

If combustion air is not supplied through air ducts, it must be supplied to the unit(s) through two permanent openings. These two openings must have a free area of **not less than one square inch (6.5 cm²) for each 4000 BTUs (1.17 kW) input for each unit**. The free area must take into account restrictions such as louvers and bird screens.

For Canada installations, refer to the requirements specified in Sections 8.4.1 and 8.4.3 of the CSA B149.1-10.

2.12.1 Ducted Combustion Air

For ducted combustion air installations, the air ductwork must be attached directly to the air inlet connection on the sheet metal enclosure. Consult the *Centurion Venting and Combustion Air Design Guide*, TAG-0102 when designing combustion air ducting.

In a ducted combustion air application, the combustion air ducting pressure losses must be taken into account when calculating the total maximum allowable venting run. When using the unit in a ducted combustion air configuration, the minimum diameter connection at the unit is 8-inch (20.3 cm) duct diameter connection.

2.13 Sequencing Isolation Valve Installation

Centurion units are pre-wired with a connection for an optional, external, actuator-controlled Sequencing Isolation Valve (P/N **21008C**). This valve is an integral component of the on-board Water Heater Management (WHM) solution. WHM allows sites with multiple Water Heaters to designate one unit as the “WHM Manager” and the others as “WHM Clients.” WHM mode ensures that the system flow will be divided between at least 2 units as demand increases, which ensures that the efficiency of the entire Water Heater array is maximized.

In addition, WHM ensures that all units receive equal run time, with additional Water Heaters activated based on the Controller’s **Next On Valve Pos** parameter (see **Main Menu → Advanced Setup → WHM Cascade → Operating Controls → Sequencing Control**).

In the case of pre-heated DHW systems with multiple units, it is highly recommended to lower the **Next On Valve Pos** parameter to 30-40% (Default=50%) so that subsequent Water Heaters are engaged sooner to provide more rapid response and divide the system flow over additional units. In DHW pre-heat systems, the required temperature rise through an individual unit can be much lower to ensure that flow per unit does not exceed 50 gal. (189 L) per minute.

Once system load is satisfied and all Client units have stopped firing, the WHM Manager opens the Sequencing Valves of units specified in *Min Unit* settings in **Main Menu → Advanced Setup → WHM Cascade → Cascade Comm**.

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

Installation consists of installing the Sequencing 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 pre-programmed Sequencing Valve control is installed on units that are part of a Water Heater Management group. See *SECTION 8: WATER HEATER MANAGEMENT*.

WHM Sequencing Isolation Valve Installation:

1. Remove the Sequencing Isolation Valve from the shipping container.
2. Attach valve to the water outlet of the unit using the pipe union and nipple provided.
3. Ensure valve is positioned with the actuator enclosure position as shown in Figure 2-19: Sequencing Valve Installation.
4. PVI recommends that another pipe nipple and flange be attached to the valve inlet prior to connecting the water piping.
5. Tighten all pipe connections after the valve is properly positioned.
6. Connect the 5-pin Molex connector on the valve to the mating connector on the Centurion harness at the rear of the unit.



Figure 2-19: Sequencing Valve Installation

2.14 Water Heater Pump Relay

The Centurion's power panel includes a secondary output board with a pump relay designed to operate a Water Heater pump. This relay provides 120 VAC with a maximum pilot duty of 3 amps. If the pump power requirement under all conditions is greater than 3 amps, it is required to use this relay to activate the pump through an intermediate relay with a higher power.

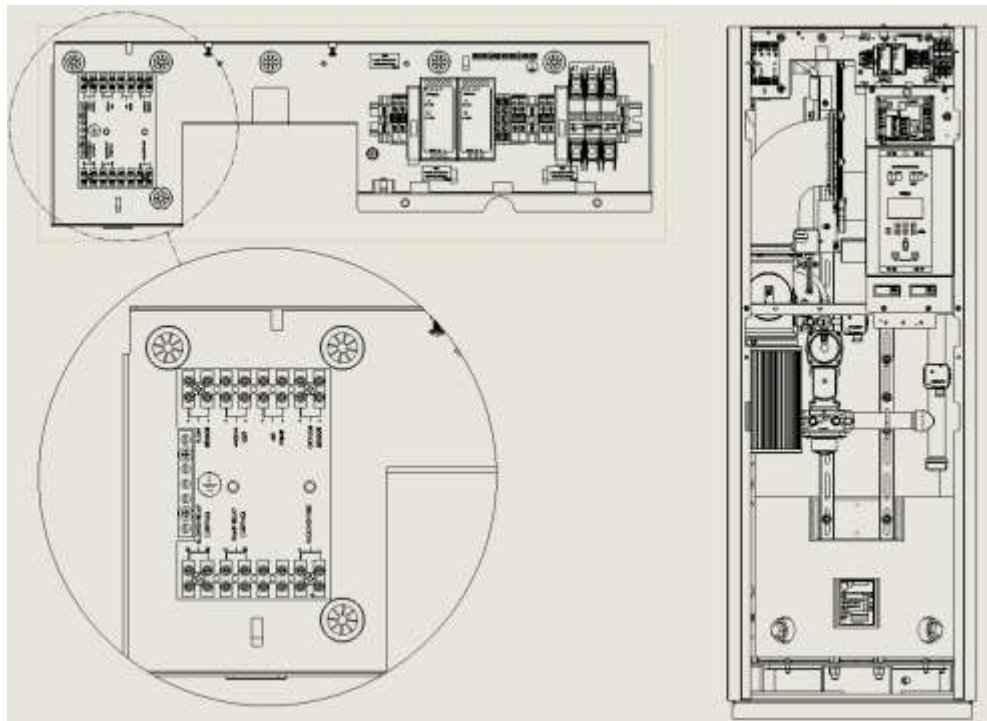


Figure 2-20: Water Heater Pump Relay

The Pump Off Delay feature allows the user to keep the pump running for up to 30 minutes after the Water Heater has shut down and the demand is satisfied. To enable this feature, go to **Main Menu → Advanced Setup → Ancillary Devices → Relay** and set the **Pump Off Delay** parameter to the number of minutes the pump will continue to pump after demand is satisfied.

2.15 Next Steps

Once the unit is physically installed per the instructions above, start the unit for the first time and perform the combustion calibration procedure. See *SECTION 5: INITIAL START-UP*.

SECTION 3: EDGE CONTROLLER OPERATION

This section provides a brief outline of how to gain access to the Water Heater’s Edge Controller functionality. Full instructions for using the Edge Controller to setup, configure and operate a Centurion Water Heater are included in the *Edge Controller Manual* (OMM-0161).

The Edge Controller is shown below. This panel contains all of the controls, indicators and displays necessary to operate, adjust and troubleshoot the Water Heater.

The Edge Controller’s front panel consists of a touchscreen display along with a variety of indicators and buttons.

1	Multi-Function Bar shows either: <ul style="list-style-type: none"> • Fire Rate • Valve Position
2	Parameter Indicator for both temperature read-outs: <ul style="list-style-type: none"> • LEFT: Inlet or Setpoint temperature • RIGHT: Outlet or System Header temperature
3	Temperature scale indicator: Fahrenheit or Celsius
4	Configurable temperature read-outs (2): <ul style="list-style-type: none"> • LEFT: Inlet or Setpoint temperature • RIGHT: Outlet or System Header temperature
5	Operation Mode Indicators (2): <ul style="list-style-type: none"> • LEFT: Demand or Manual • RIGHT: Manager or Client (WHM only)
6	Edge Controller Touchscreen
7	Soft Keys
8	Preventive Maintenance
9	Ready Light
10	Enable/Disable Switch
11	Low Water Level Buttons (2): <ul style="list-style-type: none"> • TEST: Initiates Low Water test • RESET: Resets unit after Low Water test

Figure 3-1: Edge Controller Front Panel

3.1 Login And Password Entry

The Edge Controller has multiple levels of password protection.

Level	Password	Description
1	No password	The default. Many parameters are visible but “Read Only.”
2	159	Allows for routine maintenance by PVI trained technicians.

A higher-level password for Master Technicians is distributed on an individual basis.

To enter a password:

1. On the Edge Controller, go to **Main Menu → Advanced Setup → Access**. The **Enter Password** screen appears.
2. Use the number keypad to enter the password then press **Save**. You will have access to the functionality associated with the level of the password entered.



Figure 3-2: Enter Password Screen

3. Once you have successfully logged into the system, the **Main Menu** appears. All Edge functionality is accessed through one of the six **Main Menu** items.

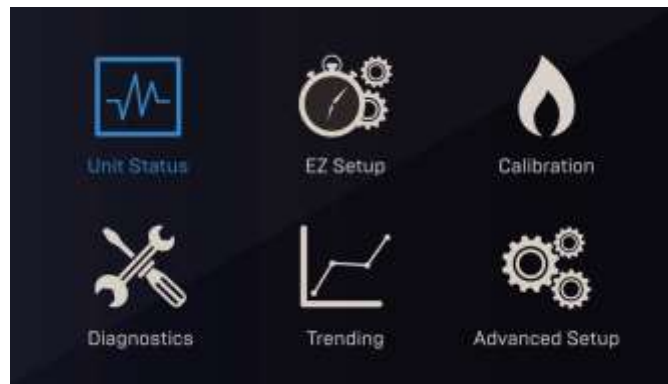


Figure 3-3: Edge Controller Main Menu

NOTE: Full instructions for the Edge Controller are in the *Edge Controller Manual* (OMM-0161).

SECTION 4: START SEQUENCE

The information in this section provides a guide to starting the Centurion Water Heater using the Edge Controller. 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. In addition, the following WARNINGS and CAUTIONS must be observed at all times.

⚠ WARNING!

All of the installation procedures in *Section 2: Installation* must be completed before the initial start-up of the unit.

This equipment must be serviced only by factory certified service technicians.

Do not attempt to dry fire the unit. Starting the unit without a full water level may result in injury to personnel or property damage and will void any warranty.

Initial startup of the unit **must be** performed by PVI factory trained personnel. Operation prior to initial startup by factory trained personnel may void the equipment warranty. In addition, the following WARNINGS and CAUTIONS must be observed at all times.

4.1 Start Sequence

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

- High Water Temperature switch
- High Gas Pressure switch
- Low Gas Pressure switch
- Low Water Level switch
- Safety Shut-Off Valve (SSOV) Proof of Closure (POC) switch

NOTE: The **Blocked Inlet** and downstream **Blower Proof** switches are **not** checked prior to pre-purge.

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

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

Start sequence when there is a demand for heat:

1. The Controller's green **DEMAND** LED status indicator will light.
2. The unit checks all five pre-purge safety switches listed above. The Edge Controller's ignition sequence screen walks you through the ignition screens and demonstrates (or highlights) which switches are not met. SSOV location is shown below.

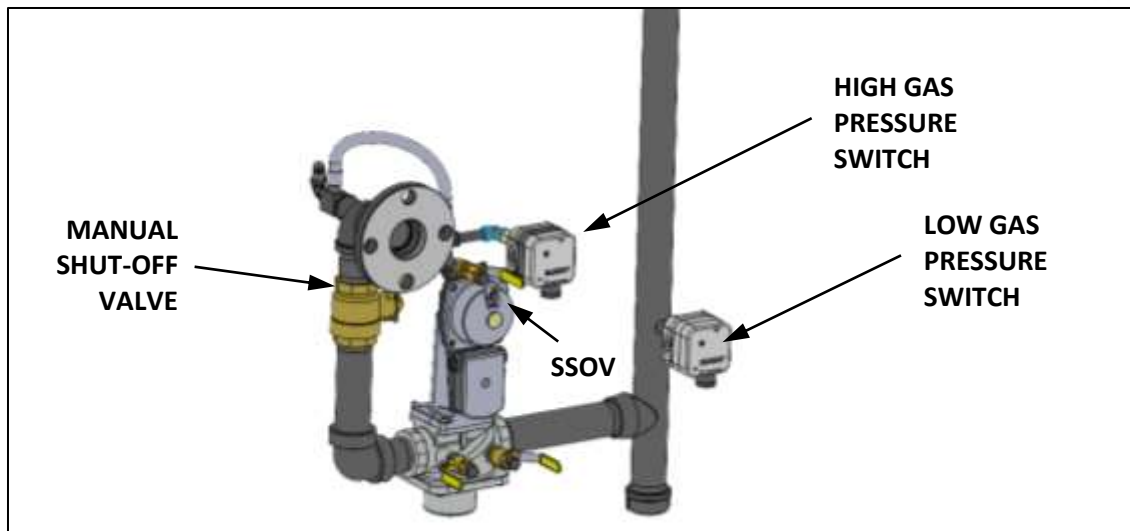


Figure 4-1: SSOV Location

3. The Auxiliary Delay occurs for a configurable length of time and the Delayed Interlocks are closed.
4. Once all required safety device switches are closed, a purge cycle is initiated, and the following events occur:
 - a. The Blower relay energizes and turns on the blower.
 - b. The Air/Fuel Valve rotates to the full-open purge position and closes purge position switch. The dial on the Air/Fuel Valve (Figure 4.2-2) will read 100 to indicate that it is full-open (100%).
 - c. The Fire Rate bar graph on the Controller's front face shows 100%.

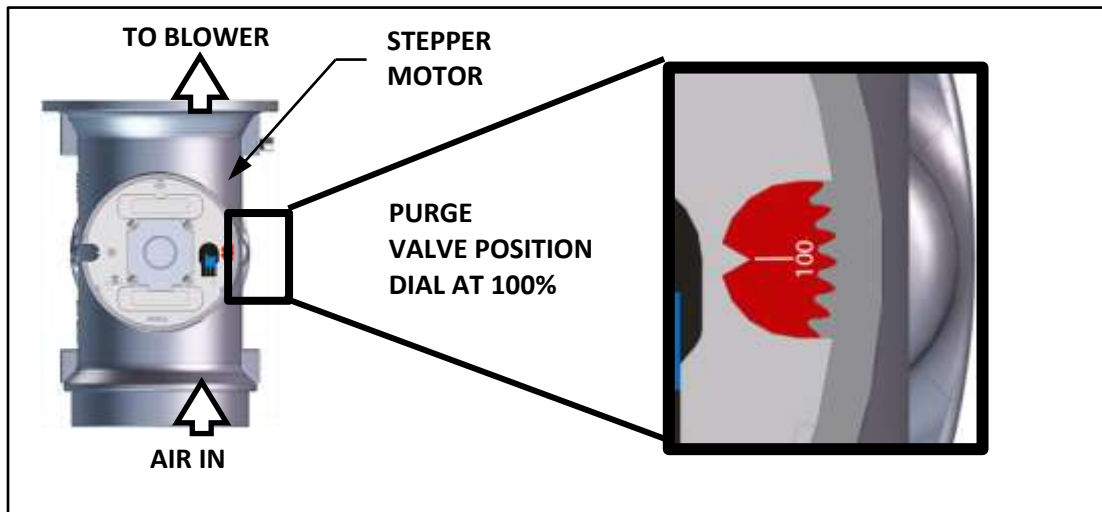


Figure 4-2: Air/Fuel Valve in Purge Position

5. Next, the Blower Proof and Blocked Inlet switches close.

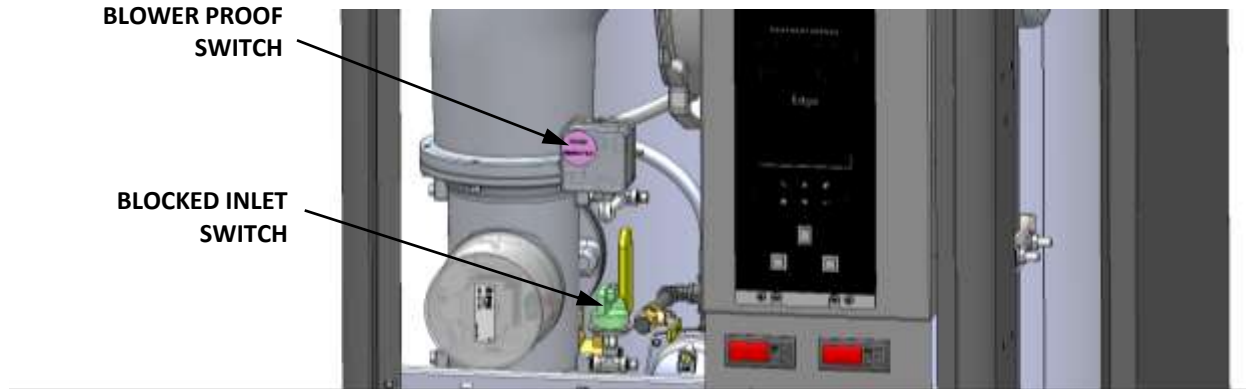


Figure 4-3: Blocked Inlet and Blower Proof Switch

6. On the Ignition Sequence screen, the **Purging** indicator turns grey while purging is underway and **Purge Timer** displays the purge cycle's elapsed time in seconds.

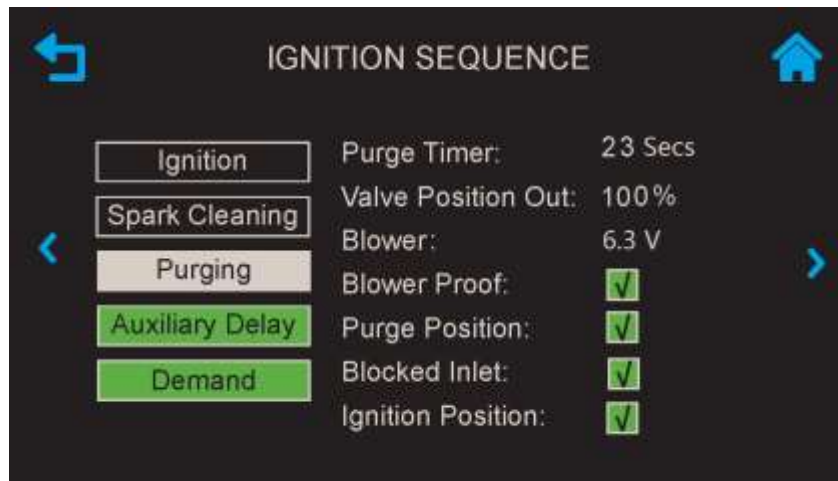


Figure 4-4: Ignition Sequence Screen – Purging

7. Upon completion of the purge cycle, the Edge Controller initiates an ignition cycle and the following events occur:
 - a) The Air/Fuel Valve rotates to the ignition position and closes the ignition switch. The Dial on the Air/Fuel Valve (Figure 4-5) will read between **25** and **35** to indicate that the valve is in the low fire position.
 - b) The Spark Cleaning cycle begins (default duration = 7 sec.) and the Ignition Sequence screen's **Spark Cleaning** indicator turns grey. This cycle turns on the ignition transformer to produce a spark (with no gas flowing) to remove moisture and carbon buildup from the spark element. For the duration of this cycle, the Controller displays the **Cleaning Igniter** status message.
 - c) Following the Spark Cleaning cycle, power is applied to the gas Safety Shut-off Valve (SSOV). When the SSOV indicates the Gas Valve is OPEN (POC), the Ignition Sequence screen's **Ignition** indicator turns grey.
 - d) If no spark is present 3 seconds into the ignition trial, the Controller aborts the Ignition Cycle and shuts down the Water Heater. Refer to **SECTION 10:** in this guide for guidance if this occurs.

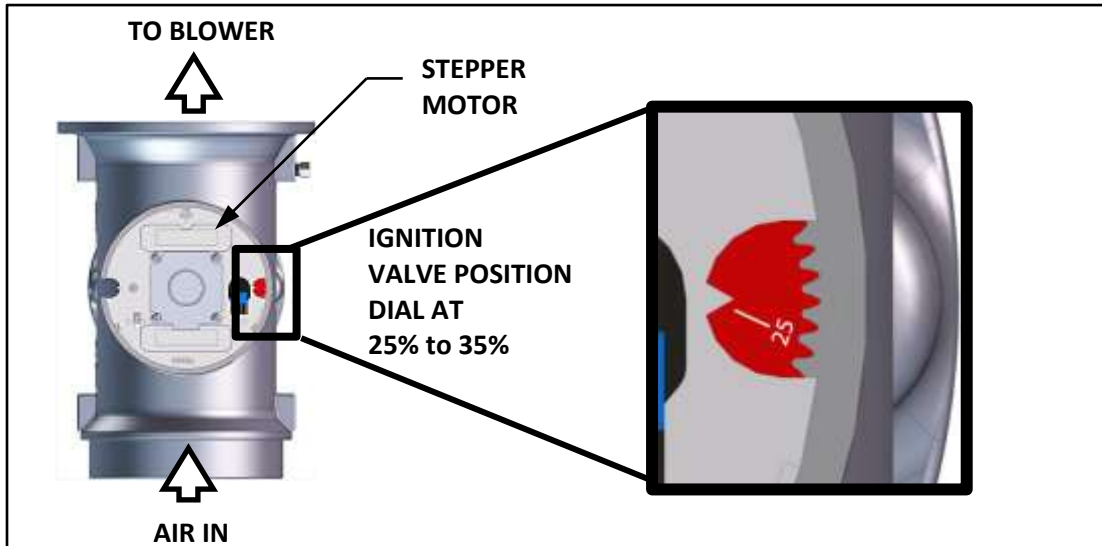


Figure 4-5: Air/Fuel Valve in Ignition Position

8. Up to 4 seconds are allowed for ignition to be detected. The ignition circuit is turned off one second after flame is detected.
9. After 2 seconds of continuous flame, the flame strength is indicated. After 5 seconds, the **Unit Status** screen appears.
10. With the unit firing properly, it will be controlled by the temperature control circuitry. The unit's fire rate or valve position (depending on which was chosen in **Main Menu** → **Advanced Setup** → **Unit** → **Front Panel Configuration**) will continuously display on the Controller's bar graph.
11. Once the demand for heat is satisfied the Controller turns off the SSOV gas valve. The blower relay is deactivated and the Air/Fuel Valve closes. **Standby** is displayed.

NOTE: Pre-purge default setting is 14 seconds, to provide four (4) air changes of the combustion chamber, heat exchanger, and exhaust manifold of the unit. This setting can be increased but should NOT be under 14 seconds, Go to **Advanced Setup > Performance > Fire Control > Purge Control > Purge Timer**.

NOTE: The purge flow rate is 408 cubic feet per minute.

4.2 Start/Stop Levels

The start and stop levels are the Air/Fuel Valve positions (% open) that start and stop the unit, based on load. These levels are factory preset and do not normally require adjustment:

Start/Stop Levels		
	NATURAL GAS	PROPANE
Start Level:	24%	24%
Stop Level:	18%	18%
Ignition Position	35%	35%

Note that energy input of the Water Heater is not linearly related to the Air/Fuel Valve position.

4.3 Start/Stop Levels – Air/Fuel & Energy Input

The tables below show the relationship between the energy input and Air/Fuel Valve position for Natural Gas.

CEN 2000 Air/Fuel Valve Position			
NATURAL GAS			
Valve Position on Controller	Air/Fuel Valve Position (% Open)	Energy Input (Btu/Hr)	Water Heater Energy Input (% Of Full Capacity)
18% (Stop Level)	18% (Stop Level)	100,000 (29.3 kW)	5%
30%	30%	310,000 (90.9 kW)	16%
40%	40%	540,000 (158.3 kW)	27%
50%	50%	770,000 (225.7 kW)	39%
60%	60%	1,030,000 (301.9 kW)	52%
70%	70%	1,290,000 (378.1 kW)	65%
80%	80%	1,560,000 (457.2 kW)	78%
90%	90%	1,840,000 (539.3 kW)	92%
100%	100%	2,000,000 (586.0 kW)	100%

CEN 1600 Air/Fuel Valve Position			
NATURAL GAS			
Valve Position on Controller	Air/Fuel Valve Position (% Open)*	Energy Input (BTU/Hr)	Water Heater Energy Input (% of Full Capacity)
18%	18% (Stop Level)	100,000 (29.3 kW)	6.3%
30%	30%	310,000 (90.9 kW)	19%
40%	40%	540,000 (158.3 kW)	34%
50%	50%	770,000 (225.7 kW)	48%
60%	60%	1,030,000 (301.9 kW)	64%
70%	66%	1,170,000 (342.9 kW)	73%
80%	71%	1,320,000 (386.9 kW)	83%
90%	77%	1,480,000 (433.7 kW)	93%
100%	82%	1,600,000 (468.9 kW)	100%

* Maximum Air/Fuel valve open position is 82% of the CEN 2000.

The tables below show the relationship between the energy input and Air/Fuel Valve position for Propane gas.

CEN 2000 Air/Fuel Valve Position			
PROPANE			
Valve Position on Controller	Air/Fuel Valve Position (% Open)	Energy Input (Btu/Hr)	Water Heater Energy Input (% Of Full Capacity)
18% (Stop Level)	18% (Stop Level)	100,000 (29.3 kW)	5%
30%	30%	310,000 (90.9 kW)	15%
40%	40%	550,000 (161.2 kW)	28%
50%	50%	790,000 (231.5 kW)	39%
60%	60%	1,050,000 (307.7 kW)	53%
70%	70%	1,330,000 (389.8 kW)	66%
80%	80%	1,590,000 (466.0 kW)	80%
90%	90%	1,860,000 (545.1 kW)	93%
100%	100%	2,000,000 (586.0 kW)	100%

CEN 1600 Air/Fuel Valve Position			
PROPANE			
Valve Position on Controller	Air/Fuel Valve Position (% Open)*	Energy Input (BTU/Hr)	Water Heater Energy Input (% of Full Capacity)
18%	18% (Stop Level)	100,000 (29.3 kW)	6.3%
30%	30%	295,000 (86.5kW)	18%
40%	40%	555,000 (162.7 kW)	35%
50%	50%	795,000 (233.0 kW)	50%
60%	60%	1,040,000 (304.8 kW)	65%
70%	66%	1,195,000 (350.2 kW)	75%
80%	71%	1,325,000 (388.3 kW)	83%
90%	77%	1,475,000 (432.3 kW)	92%
100%	82%	1,600,000 (468.9 kW)	100%

* Maximum Air/Fuel valve open position is 82% of the CEN 2000 Propane.

SECTION 5: INITIAL START-UP

5.1 Initial Start-Up Requirements

- Complete installation instructions SECTION 2:, including gas supply piping, vent installation and condensate drain piping. Starting a unit without the proper piping, venting, or electrical systems can be dangerous and may void the product warranty.
- Set proper controls and limits (see Section 6: *Advanced Setup* in the *Edge Controller Manual*, OMM-0161).

PVI recommends that the **Standby Blower Voltage** parameter be kept at 2.00 volts (the default set at the factory) to prevent flue gas recirculation. To check, go to **Main Menu → Advanced Setup → Performance → Fire Control → Operating Control** and verify the **Standby Blower Voltage** parameter is set to **2.00 V**. However, individually vented units in positive pressure Water Heater rooms may set Standby Blower Voltage between 2.00 and 0 volts to compensate.



Figure 5-1: Operating Control Screen

Initial start-up consists of the following:

- **REMOVE THE AIR FILTER BAG BEFORE STARTING THE UNIT**
- Combustion calibration (Section 5.3)
- Test safety devices (Section 6)

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 and at high thermal efficiency and low flue gas emissions.

⚠ WARNING!

DO NOT ATTEMPT TO DRY FIRE THE UNIT. Starting the unit without a full water level can seriously damage the unit and may result in injury to personnel and/or property damage. This situation will void any warranty.

REMOVE THE AIR FILTER BAG BEFORE STARTING THE UNIT.

Initial unit start-up ***must be*** performed by a PVI factory trained technician.

A Startup Report sheet (included with each unit and available on PVI.com) must be completed for each unit for warranty validation and a copy must be returned promptly to PVI Customer Support via e-mail at: customercare@pvi.com.

5.2 Tools & Instruments for Combustion Calibration

To properly perform combustion calibration, the proper instruments and tools must be used and correctly attached to the unit. The following sections outline the necessary tools and instrumentation as well as their installation.

5.2.1 Required Tools & Instrumentation

The following tools and instrumentation are necessary to perform combustion calibration:

- Digital Combustion Analyzer: Oxygen accuracy to $\pm 0.2\%$; Carbon Monoxide (CO) and Nitrogen Oxide (NOx) resolution to 1 PPM
- 0 to 16 inch W.C. (0 to 4.0 kPa) manometer or equivalent gauge and plastic tubing
- 1/4-inch NPT-to-barbed fittings for use with gas supply manometer
- Small and large flat blade screwdrivers
- Tube of silicone adhesive

5.2.2 Installing Gas Supply Manometer

A 16" W.C. (4.0 kPa) gas supply manometer (or gauge) is used in the following ways:

- Mounted on the **upstream** side of the SSOV to verify that the gas supply pressure is within the required range of 4" W.C. to 14" W.C. for Natural gas, and 8" W.C. to 14" W.C. for Propane gas.
 - Mounted on the **downstream** side of the SSOV to monitor the gas pressure during the Combustion Calibration procedure, described in Section 5.3.
1. Turn off the main gas supply upstream of the unit.
 2. Remove the top panel and/or front panel from the Water Heater to access the gas train.
 3. Remove the 1/4" NPT plug from the leak detection ball valve on the upstream or downstream side of the SSOV, as needed during testing, as shown in the Figure below.
 4. Install an NPT-to-barbed fitting into the tapped plug port.
 5. Attach one end of the plastic tubing to the barbed fitting and the other end to the 16" W.C. (4.0 kPa) manometer.

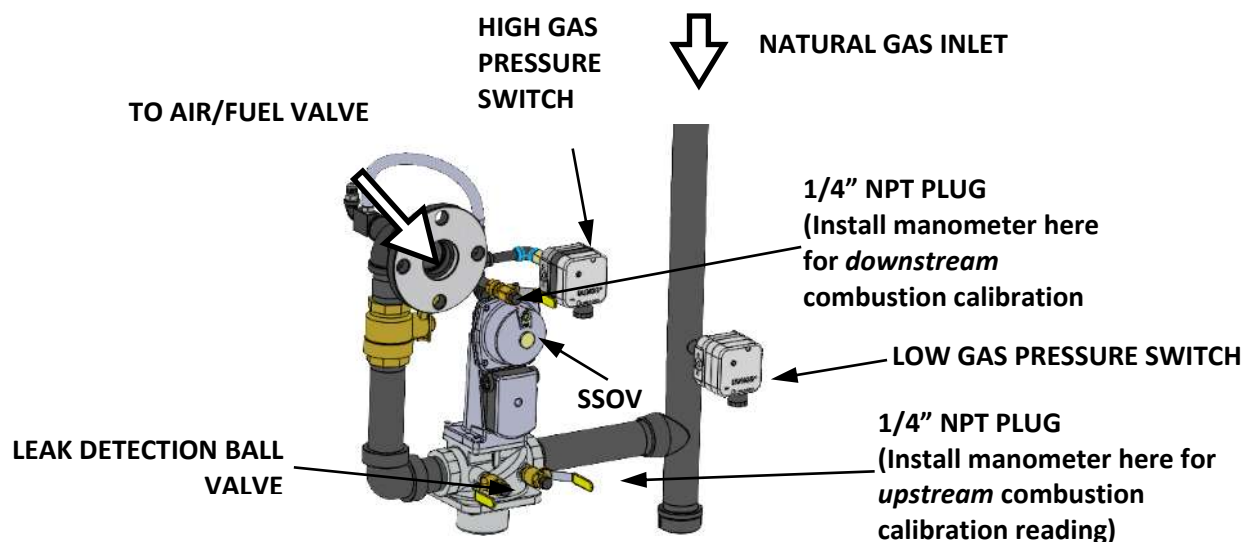


Figure 5-2: 1/4 Inch Gas Plug Location

5.2.3 Accessing The Analyzer Probe Port

1. Remove the 1/4" NPT plug from the exhaust manifold.
2. If necessary, adjust the stop on the combustion analyzer probe so it will extend mid-way into the flue gas flow. **DO NOT install the probe at this time.**

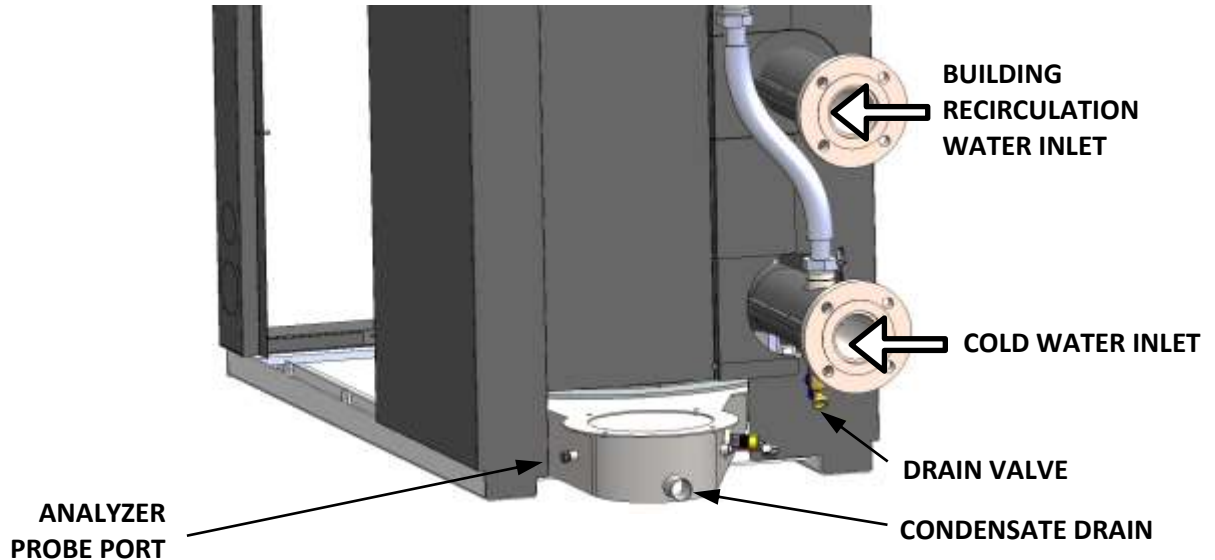


Figure 5-3: Analyzer Probe Port Location

5.2.4 Recommendations For WHM Operation

It is strongly recommended that installations with multiple Centurion units operate in Water Heater Management (WHM) mode (see Section 2.13 for instructions on installing the actuator-controlled Sequencing Isolation Valve). This is to ensure the system flow is divided between units as demand increases, and that all units receive equal run time and additional Water Heaters are activated based on the **Next On Valve Pos** firing rate setting.

In case of pre-heated DHW systems with multiple Centurion units, it is recommended to lower the **Next On Valve Pos** setting to 30-40% (Default=50%), so subsequent Water Heaters are engaged sooner to provide rapid response and divide the system flow over additional units. In case of DHW pre-heat systems, the required temperature rise through an individual unit can be much lower to ensure flow per unit does not exceed 50 gal. (189 L) per minute.

5.3 Combustion Calibration

Centurion Water Heaters are set up for either Natural Gas or Propane gas, as specified by the Style Number on the Sales Order, and if applicable calibrated for Standard NO_x emissions (<20 ppm) before shipping.

Recalibration as part of initial start-up is necessary due to changes in the local altitude, gas BTU content, gas supply piping and supply regulators. Combustion Calibration Test Data sheets, shipped with each unit, must be filled out and returned to PVI for proper Warranty Validation. It is important to perform the combustion calibration procedure below to provide optimum performance and keep readjustments to a minimum.



Figure 5-4: Gas Pressure Adjustment Screw and TAC Screw Location

WARNING:

Combustion calibration and O₂ Trim can both alter the calibration voltage to the blower and thus interfere with each other. If O₂ Trim is enabled and a change is made to any calibration point during combustion calibration you must make a corresponding change to the O₂ Target, O₂ Lower Limit and O₂ Upper Limit in **Main Menu → Advanced Setup → Performance → O₂ Trim → O₂ Trim Parameters** (see Section 9.2 – O₂ Sensor Calibration).

5.3.1 Instructions For Combustion Calibration

1. Ensure the Edge Controller's Enable/Disable switch is set to **Disable**.
2. Open water supply and return valves to unit and ensure system pumps are running.
3. Open the **NATURAL GAS** or **PROPANE GAS** supply valve to the unit.
4. Turn external AC power to the unit **ON**.
5. Go to: **Main Menu → Calibration → Manual Combustion**; if necessary, enter a technician level password.
6. After the first **Manual Combustion Calibration** screen appears:
 - Verify incoming (upstream) gas pressure is within the allowable range (Section 2.8.1).
 - Connect gas manometer to upstream side of gas train's SSOV (Section 5.2.2) and connect the Combustion Analyzer (Section 5.2.3).
 - Ensure heating loop is capable of dissipating sufficient heat at full fire. In addition, if your unit is running O₂ Trim, you must turn that feature OFF before continuing; O₂ Trim will interfere with combustion calibration.

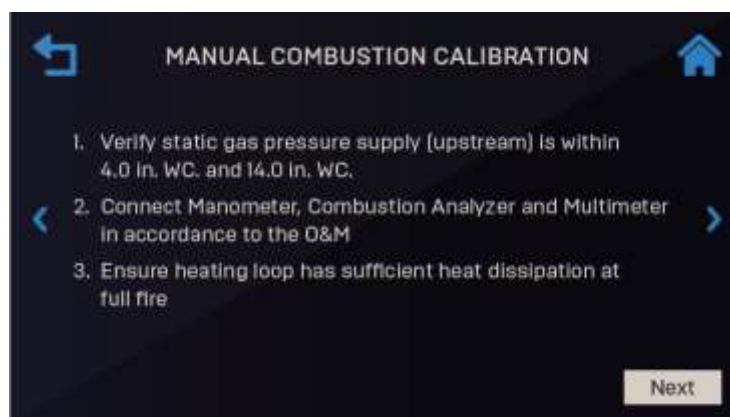


Figure 5-5: First Manual Combustion Calibration Screen

7. Once you have completed the previous steps, move the manometer (or use a secondary one) to the **downstream** side of the SSOV and press **Next** to continue.
8. Choose the NOx requirement for this installation: **None** or **<= 20 PPM**.



Figure 5-6: Choose NOx Requirement

9. The main **Manual Combustion Calibration** screen appears. It provides two methods to ramp the unit's valve position up or down:
 - **Method 1:** Toggle through the pre-set calibration points till you reach the desired valve position, then press **Go** to go to that point (left image below).
 - **Method 2:** Enable **Fine VP Step**, then manually press the **+** or **-** buttons once per 1% to bring the unit to the desired valve position (right image below).



Preset Calibration Points Method

Fine VP Step Method

Figure 5-7: Manual Combustion Calibration screen

10. Set the Controller's Enable/Disable switch to **Enable**.
11. Change the valve position to 30%, press the **Go** button, then verify that the unit has ignited and is operating as expected.
12. Use the ► (Right) arrow key to change the valve position to **100%**, then press **Go**.
13. Verify the manifold gas pressure on **downstream** side of the SSOV is within required range shown below. If it isn't, remove the brass hex nut on the SSOV actuator to access the gas pressure adjustment screw (Figure 5-4). Using a flat-tip screwdriver, slowly rotate the gas pressure adjustment (in 1/4-turn increments) **clockwise to increase** gas pressure or **counterclockwise to reduce** it. The resulting gas pressure reading on the **downstream** manometer should fall in the range listed below.

Manifold Gas Pressure @ 100% Fire Rate		
Model	Natural Gas	Propane Gas
CEN 2000	1.6" ± 0.1" W.C. (0.40 ± 0.02 kPa)	1.9" ± 0.1" W.C. (0.47 ± 0.02 kPa)
CEN 1600	1.7" ± 0.1" W.C. (0.42 ± 0.02 kPa)	1.9" ± 0.1" W.C. (0.47 ± 0.02 kPa)

SECTION 5: INITIAL START-UP

14. With the valve position still at 100%, insert the combustion analyzer probe into the exhaust manifold probe opening (see Section 5.2.3) and allow enough time for the combustion analyzer reading to stabilize.
15. Compare the combustion analyzer's oxygen (O₂) reading to the O₂ value in the **Reading** column. If they differ, go to the **Main Menu → Calibration → Input/Output → O₂ Sensor** screen and adjust the **O₂ Offset** parameter, up to **±3%**, to make the on-board O₂ sensor match the value from the combustion analyzer. If your combustion analyzer is correctly calibrated, and the on-board O₂ sensor cannot be made to match the analyzer, the sensor may be defective.
16. Compare the O₂ value in the **Target** and **Reading** columns. If they don't match, adjust the **Blower Voltage** until the O₂ value in both columns match; use either the **+** or **-** controls, or press on the field and type the value directly.
17. If adjusting blower voltage is not sufficient to get **O₂ Reading** column to match **Target** column, repeat Step 13 to adjust gas pressure to within the range shown in the table, then repeat Step 16. Continue until the gas pressure is within the range in the Manifold Gas Pressure Table above and the **O₂ Reading** column matches the **Target** column.
18. Enter the downstream manometer's gas pressure reading in the **Downstream Gas Pressure** field. Note, this field appears only when **Valve Position % = 100%**.
19. Compare the measured nitrogen oxide (NO_x) and carbon monoxide (CO) readings to the Target Values shown below. If you are not in a "NO_x-limited" area and/or do not have a NO_x measurement in your analyzer, set the O₂ to the value in the Standard NO_x column.

NATURAL GAS Target Values @ 100% Valve Position			
Model	Standard NO_x		CO
	O₂ %	NO_x	
CEN 2000/1600	5.6% ± 0.2%	≤20 ppm	<100 ppm

PROPANE GAS Target Values @ 100% Valve Position		
Model	O₂ %	CO
CEN 2000/1600	5.6% ± 0.2%	<100 ppm

NOTE: These instructions assume that the **inlet air temperature is 50°F - 100°F (10°C - 37.8°C)**. If NO_x readings exceed the target values above, increase the O₂ level up to 1% higher than the Target value. Record the increased O₂ value on the Combustion Calibration sheet.

20. Once the O₂ level is within the specified range at 100%:
 - **Enter the NO_x and CO readings from the Combustion Analyzer and multi-meter in the Manual Combustion Calibration screen's Reading column.**
 - **Enter the same values, plus the O₂ value, on the Combustion Calibration Data Sheet provided with the unit.**
21. Lower the Valve Position to the next calibration point using the **◀** (Left) arrow key (if using Method 1 in Step 9) or the Fine Valve Position **-** (Minus) key (if using Method 2).

22. Repeat Step 15, 16 and 19 at that position and the rest of the valve positions in the tables below. The O₂, NO_x and CO should stay within the ranges shown.

NATURAL GAS Final Valve Positions for CEN 2000			
Valve Position	Standard NO _x		CO
	O ₂ %	NO _x	
80%	5.6% ± 0.2%	≤20 ppm	<100 ppm
70%	5.6% ± 0.2%	≤20 ppm	<100 ppm
60%	5.6% ± 0.2%	≤20 ppm	<100 ppm
50%	5.6% ± 0.2%	≤20 ppm	<100 ppm
40%	5.8% ± 0.2%	≤20 ppm	<50 ppm
30%	5.6% ± 0.2%	≤20 ppm	<50 ppm
18%	5.6% ± 0.2%	≤20 ppm	<50 ppm

NATURAL GAS Final Valve Positions for CEN 1600			
Valve Position	Standard NO _x		CO
	O ₂ %	NO _x	
80%	5.6% ± 0.2%	≤20 ppm	<100 ppm
70%	5.6% ± 0.2%	≤20 ppm	<100 ppm
60%	5.6% ± 0.2%	≤20 ppm	<100 ppm
50%	5.6% ± 0.2%	≤20 ppm	<100 ppm
40%	5.6% ± 0.2%	≤20 ppm	<50 ppm
30%	5.6% ± 0.2%	≤20 ppm	<50 ppm
18%	5.6% ± 0.2%	≤20 ppm	<50 ppm

PROPANE GAS Final Valve Positions for CEN 2000		
Valve Position	O ₂ %	CO
80%	5.5% ± 0.2%	<100 ppm
70%	5.5% ± 0.2%	<100 ppm
60%	5.5% ± 0.2%	<100 ppm
50%	5.5% ± 0.2%	<100 ppm
40%	5.5% ± 0.2%	<100 ppm
30%	5.5% ± 0.2%	<100 ppm
18%	5.5% ± 0.2%	<100 ppm

PROPANE GAS Final Valve Positions for CEN 1600		
Valve Position	O ₂ %	CO
80%	5.5% ± 0.2%	<100 ppm
70%	5.5% ± 0.2%	<100 ppm
60%	5.5% ± 0.2%	<100 ppm
50%	5.5% ± 0.2%	<100 ppm
40%	5.5% ± 0.2%	<100 ppm
30%	5.5% ± 0.2%	<100 ppm
18%	5.5% ± 0.2%	<100 ppm

NOTE: If NOx readings exceed the above values, increase O₂ up to 1% higher than the listed calibration range in the table. Record the increased O₂ value on the Combustion Calibration sheet.

23. If the oxygen level at the lowest valve position is too high and the Blower voltage is at minimum, you can adjust the TAC screw, recessed in the top of the Air/Fuel Valve (see Figure 5-4, above). Rotate the screw 1/2 turn **clockwise (CW) to add fuel and reduce the O₂** to the specified level. After adjusting the TAC screw, recalibration must be performed again from 60% or 50% down to the lowest valve position.

5.3.2 Reassembly

Once the combustion calibration adjustments are properly set, the unit can be reassembled for service operation.

1. Set the Controller's Enable/Disable switch to the **Disable** position.
2. Disconnect AC power to the unit.
3. Shut off the gas supply to the unit.
4. Remove the manometer and barbed fittings and reinstall the NPT plug using a suitable pipe thread compound.
5. Remove the combustion analyzer probe from the 1/4" vent hole in the exhaust manifold and then replace the 1/4" NPT plug in the vent hole. Replace all previously removed sheet metal enclosures on the unit.

5.4 Over-Temperature Limit Switches

The unit contains two configurable over-temperature limit controls, positioned behind the unit's front panel, under the Edge Controller:

- **Automatic Reset:** If the unit's operating temperature exceeds the limit set on the switch, it goes into alarm mode and shuts the unit down. When the temperature falls 10 degrees below the limit, the unit automatically resumes operation without operator intervention. The limit range is manually adjustable from 32°F to 190°F (0°C to 87.8°C). The default value is 160°F (71.1°C).
- **Manual Reset:** If the unit's operating temperature exceeds the limit set on the switch, the switch goes into alarm mode and shuts the unit down. The unit **cannot be restarted until the switch is reset manually**. The limit is preset to 200°F (93.3°C) and **should not be changed**.

Note the following points:

- Both switches display the temperature to which the switch is set (the temperature limit), **not** the actual temperature it is reading.
- Both switches can display temperatures in Fahrenheit or Celsius.
- The **Auto-Reset** switch is preset to 160°F (71°C) but can be adjusted as needed to suit local conditions, as described below.



Figure 5-8: Over-Temperature Limit Switches

5.4.1 Adjusting The Automatic Reset Limit Switch Temperature

1. Power unit ON and remove the front panel to expose the Over-Temperature Limit switches.
2. Press the Automatic Reset Limit Switch's SET button: SP appears in the display.
3. Press the SET button again. The current setting stored in memory is displayed.
4. Press the ▲ or ▼ arrow buttons to change the display to the desired temperature setting.
5. When the desired temperature is displayed, press the SET button.
6. Press both the SET and ▼ arrow buttons at the same time. This stores the setting in memory; note that OUT1 appears in the upper-left corner of the display as confirmation.

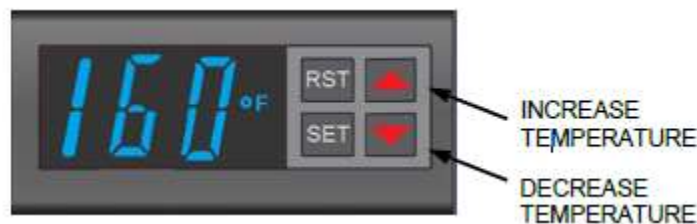


Figure 5-9: Auto-Reset Over-Temperature Limit Switch

5.4.2 Resetting The Manual Reset Limit Switch

Perform the following steps to rest the Manual Reset Limit Switch after it has gone into Alarm mode, and after the temperature has fallen at least 10 degrees below the limit.

1. Power unit **ON** and remove front panel to expose Over-Temperature Limit switches.
2. Press the Manual Reset Limit Switch's **RST** (Reset) button.
3. You can now restart the unit.



Figure 5-10: Manual Reset Over-Temperature Limit Switch

5.4.3 Changing The Readout Between Fahrenheit and Celsius

1. Press and hold both the **Increase** and **Decrease** arrows at the same time for about 4 seconds. The display shows the temperature in Celsius and °F changes to °C.
2. To change the display back to Fahrenheit, repeat step 1.



Figure 5-11: Changing the Display to Celsius

5.5 Temperature Control Calibration

⚠ WARNING!

Ignoring this commissioning step may cause water temperature faults, poor water temperature control, and rapid cycling of the unit.

The unit normally comes factory set and calibrated for a 130°F (54.4°C) setpoint (default value). However, if a different setpoint temperature is desired, use the procedure in the next section. Temperature control calibration should be performed each time the setpoint is changed.

There are two primary adjustments for performing temperature calibration: **Min Load Adj** and **Max Load Adj** (minimum and maximum load adjustment). Adjustments to these settings are made at minimum and maximum load conditions and should be made in small increments, from 1 to 3 degrees F (0.55 to 1.65 degrees C). After adjustment the outlet water temperature must be allowed to settle for several minutes prior to making any further adjustments.

Temperature control calibration is accomplished by first performing the procedure in Section 5.5.2 *Minimum Load Adjustment*. Once complete, perform the procedure in Section 5.5.3 *Maximum Load Adjustment*.

5.5.1 Setting Outlet Water Temperature Setpoint

If the setpoint is already set to the correct values for the site skip this step and proceed to 5.5.2.

Setting Outlet Temperature Setpoint – WHM Manager Units:

1. On the WHM Manager unit go to **Advanced Setup → WHM Cascade → Application Configuration**.
2. Set the **Setpoint** parameter to the desired setpoint.

Setting Outlet Temperature Setpoint – Standalone Units:

1. On a standalone unit, go to: **Advanced Setup → Unit → Application Configuration.**
2. The setpoint for the WHM Cascade can be a constant, or received from a remote source, such as a BAS.

If Operating Mode = Constant Setpoint: Set WHM Setpoint to the desired setpoint.

If Operating Mode = Remote Setpoint: Choose the source of the remote setpoint:

- 4-20 mA
- 1-5 V
- BAS (Building Automation System)
- 0-20 mA
- Network
- 0-5 V

5.5.2 Minimum Load Adjustment

With the unit in operation, check the temperature control at minimum load as described below.

1. Go to: **Advanced Setup → Performance → Temperature Control → FFWD Settings.**

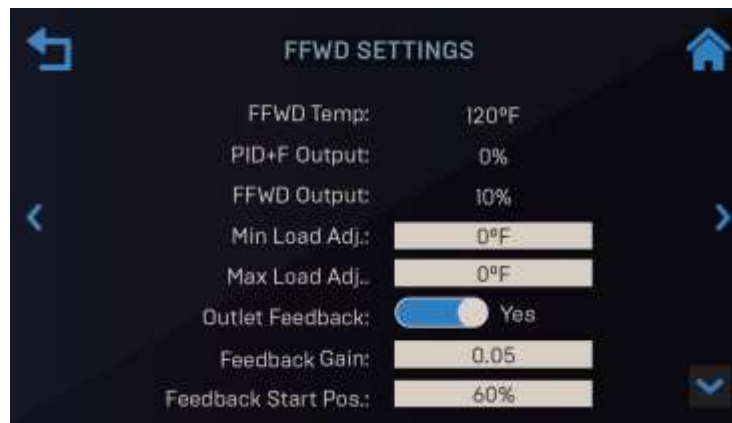


Figure 5-12: FFWD Settings Screen

2. Set the **Outlet Feedback** parameter to **No**.
3. While monitoring the Valve Position bar-graph, create a minimum load on the system that will yield a steady valve position between 25% and 35%.

NOTE: It may be desirable to shut off the outlet valve and use the drain valve on the water inlet pipe to simulate a minimum load condition.

4. Wait several minutes to allow the outlet temperature to stabilize under load conditions.
5. Once stabilized, the outlet temperature should be within 3°F of the unit's setpoint.
6. If the outlet temperature is stabilized, proceed to Section 5.5.3: *Maximum Load Adjustment*. If the temperature is not stabilized, proceed to step 7.
7. Raise or lower the **Min Load Adj** by one or two degrees (*increasing* it will *increase* outlet water temperature), then allow a few minutes for the system to stabilize.
8. Repeat step 7 as needed until the temperature is stabilized within 2-3 °F (1.1 to 1.65 °C) of the unit's setpoint.
9. Proceed to Section 5.5.3: *Maximum Load Adjustment*.

5.5.3 Maximum Load Adjustment

Check the temperature control at maximum load as follows:

1. Go to: **Advanced Setup** → **Performance** → **Temperature Control** → **FFWD Settings**.
2. Ensure the **Outlet Feedback** parameter is set to **No**.
3. While monitoring the Valve Position bar-graph, create a maximum load on the system that will yield a steady valve position between 80% and 90%.
4. Wait 2-3 minutes to allow the outlet water temperature to stabilize under load conditions.
5. Once stabilized, the outlet temperature should be within 3°F of the unit's setpoint.
6. If the outlet temperature is stabilized, no adjustment is necessary. If the temperature is not stabilized, proceed to step 7.
7. Raise or lower **Max Load Adj** (*increasing* it will *increase* outlet water temperature), then allow 2-3 minutes for the system to stabilize.
8. Repeat step 7 as needed until the temperature is stabilized within 2-3 °F (1.1 to 1.65 °C) of the unit's setpoint.
9. Set the **Outlet Feedback** parameter back to **Yes**.
10. If the outlet temperature does not maintain setpoint after a reasonable amount of time and adjustment, contact your local PVI representative.

5.6 Modes Of Operation

Centurion Water Heaters operate in either **Constant Setpoint** or **Remote Setpoint** mode of operation. The unit is factory preset with settings that work well, however, the setpoint temperature is adjustable from 60°F to 170°F (15.6°C to 76.7°C).

As a prerequisite to both modes, you must ensure that the unit is ***not*** a WHM Client or Manager.

1. Go to: **Advanced Setup** → **WHM Cascade** → **Cascade Configuration**.
2. Verify that WHM Unit Mode = OFF.



Figure 5-13: Cascade Configuration Screen

5.6.1 Constant Setpoint Mode

Constant Setpoint mode is used to change the factory preset temperature to suit the demands of the site. No external sensors are required. To set the unit to **Constant Setpoint** mode:

1. Go to: **Advanced Setup** → **Unit** → **Application Configuration**.



Figure 5-14: Application Configuration Screen

2. Set the Operating Mode to **Constant Setpt**.
3. Set the **Setpoint** to the desired value, adjustable from 60°F to 170°F (15.6°C to 76.7°C).
4. Set the **Setpoint Low Limit**, adjustable from 40°F to 245°F (4.4°C to 118.3°C) and **Setpoint High Limit** (40°F to 220°F, 4.4°C to 104.4°C) to the desired values.
5. Depending on whether the site contains any storage tanks, set **DHW Tank Config** to **No Tanks**, **One Tank** or **Two Tanks**.

5.6.2 Remote Setpoint Mode

In this mode the unit adjusts the setpoint in response to a remote signal. You must specify how the unit will communicate with the remote source. To set the unit to **Remote Setpoint** mode:

1. Go to: **Advanced Setup** → **Unit** → **Application Configuration**.

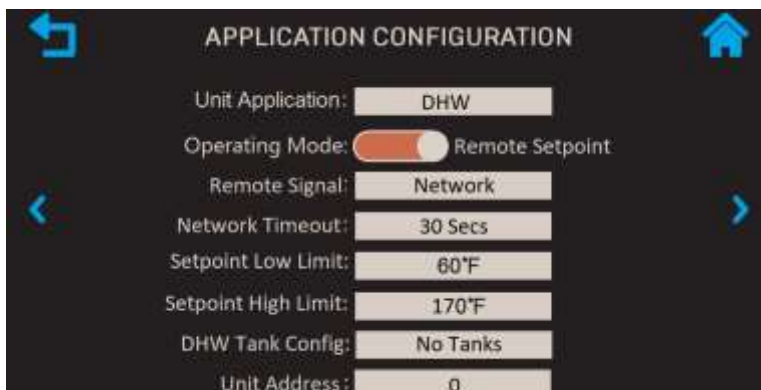


Figure 5-15: Application Configuration Screen

2. Set the **Operating Mode** to **Remote Setpoint**.
3. Set the **Remote Signal** to the source of the remote signal:
 - 4-20 Ma
 - 0-20 mA
 - BAS
 - PWM Input
 - 1-5 V
 - Network
 - 0-5 V
4. Set the **Setpoint Low Limit** and **Setpoint High Limit** to the desired values.
5. Depending on whether the site contains any storage tanks, set **DHW Tank Config** to **No Tanks**, **One Tank** or **Two Tanks**.
6. If **Remote Signal** is set to **Network**, set **Unit Address** to the unit's network address.

SECTION 6: SAFETY DEVICE TESTING

6.1 Testing Safety Devices

Periodic safety device testing is required to ensure that the control system and safety devices are operating properly. The Water Heater control system comprehensively monitors all combustion-related 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.

NOTE: **Manual** and **Auto** modes are required to perform the following tests. For a full explanation, see *Edge Controller Manual*, OMM-0161 Section 4.1.

NOTE: Front door and side panels must be removed to perform the tests described below.

⚠ WARNING!
Disable power prior to wire removal or other procedures that can cause electrical shock.

A number of the Safety Device test procedures require the unit to be run in Manual Mode. This is enabled by going to **Main Menu** → **Diagnostics** → **Manual Run**, then enabling the **Manual Mode** control. Once this is done, the **Comm** LED on the Controller's front face will go off and the **MANUAL** LED will light.



Figure 6-1: Manual Run Screen

6.2 Low Gas Pressure Test

To simulate a low gas pressure fault:

1. Remove the front panel from the Water Heater to access the gas train components.
2. Make sure the 1/4" ball valve located at the inlet side of the SSOV is closed.
3. Remove the 1/4" NPT plug from the ball valve.
4. Install a **0-16" W.C. (0-4 kPa)** manometer or gauge where the 1/4" plug was removed.
5. Slowly open the 1/4" ball valve.
6. Go to **Main Menu → Diagnostics → Manual Run** to enable the **Manual Mode** control
7. Adjust the Air/Fuel Valve position **between 25% and 30%** using the **+** and **-** controls.
8. While the unit is firing, slowly close the external manual gas shut-off valve upstream of the unit (not shown).
9. The unit should shut down and display **Fault Lockout - Gas Pressure Fault** at approximately the pressure shown below:

LOW Natural Gas Pressure, ± 0.2" W.C. (± 50 Pa)	
Model	Natural Gas
CEN 2000/1600 FM & DBB Single-Fuel	3.8" W.C. (946 Pa)

LOW Propane Pressure, ± 0.2" W.C. (± 50 Pa)	
Model	Natural Gas
CEN 2000/1600 FM & DBB Single-Fuel	8.0" W.C. (1.5 kPa)

10. Close the 1/4" ball valve (opened in Step 5).
11. Fully open the external manual gas shut-off valve (not shown) and press **CLEAR** button.
12. The fault message should clear, **FAULT** indicator turn off, and the unit should restart.
13. Upon test completion, close the ball valve, remove the manometer and replace the 1/4" NPT plug removed in step 3.

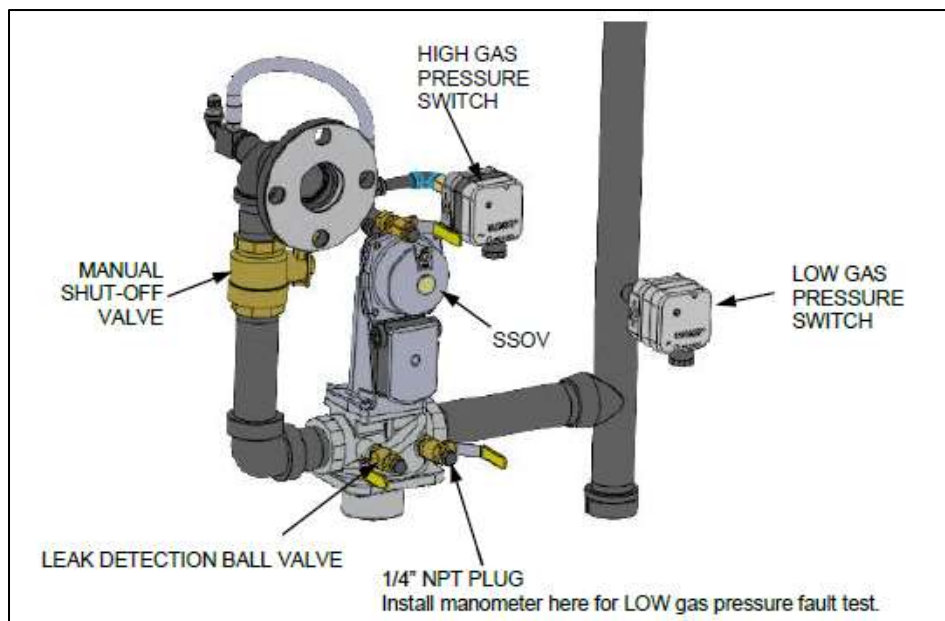


Figure 6-2: LOW Gas Pressure Test Components

6.3 High Gas Pressure Test

To simulate a high gas pressure fault, refer to Figure 6-4 and perform the following steps:

1. Close the 1/4" ball valve located at the High Gas Pressure switch.
2. Remove 1/4" NPT plug from the ball valve (Figure 6-4).
3. Install a **0-16" W.C. (0-4 kPa)** manometer or gauge where the 1/4" plug was removed.
4. Slowly open the leak detection ball valve.
5. Go to **Main Menu → Diagnostics → Manual Run** and enable **Manual Mode** control.
6. Set the valve position **between 25% and 30%** using the **+** (Plus) and **-** (Minus) controls.
7. With unit running, monitor gas pressure on the manometer. Record pressure reading.
8. Slowly increase the gas pressure using the adjustment screw on the SSOV **while counting the number of turns you make**.
9. The **FAULT** indicator should start flashing and the unit should shut down and display a **Fault Lockout - Gas Pressure Fault** message at approximately the value shown in Table 6.3 (the High Gas Pressure switch setting). If the unit does not trip off within 0.2" W.C. of the pressure shown, the switch needs to be replaced.

HIGH Natural Gas Pressure, ± 0.2" W.C. (± 50 Pa)	
Model	Natural Gas
CEN 2000/1600 FM & DBB Single-Fuel	2.4" W.C. (0.6 KPa)

HIGH Propane Pressure, ± 0.2" W.C. (± 50 Pa)	
Model	Natural Gas
CEN 2000/1600 FM & DBB Single-Fuel	2.85" W.C. (0.71 KPa)

10. Reduce the gas pressure by returning the SSOV adjustment screw to its original position (the value recorded in step 8). This pressure should be within the range used during combustion calibration, shown in the table above.
11. Unscrew and remove the plastic cover on the High Gas Pressure Switch and press the red reset button. Replace cover.
12. Press the **CLEAR** button on the Edge Controller to clear the fault.
13. The fault message should clear, the **FAULT** indicator should go off and the unit should restart (if in **Manual** mode).
14. Upon test completion, close the ball valve and remove the manometer. Replace the 1/4" NPT plug removed in step 2.



Figure 6-3: High Gas Pressure Switch

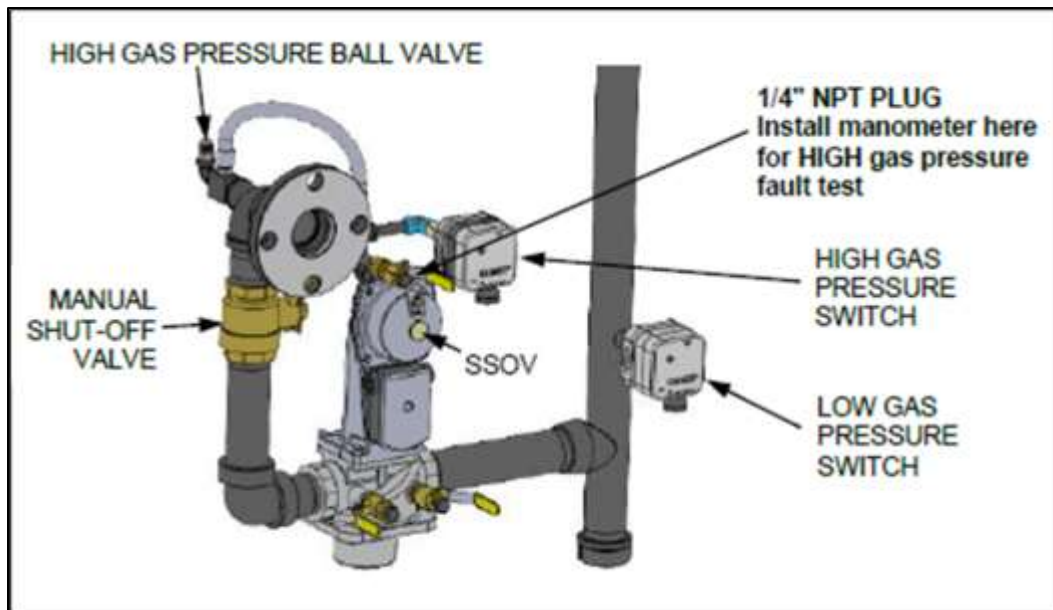


Figure 6-4: HIGH Gas Pressure Test Components

6.4 Low Water Level Fault Test

1. Set the Controller's **Enable/Disable** switch 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 FAULT indicator flashes.
5. Go to **Main Menu → Diagnostics → Manual Run** and enable **Manual Mode**.
6. Raise the valve position **above 30%** using the + (Plus) and - (Minus) controls.
7. Set the Controller's **Enable/Disable** switch 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.
8. Close the drain and pressure relief valve used in draining the unit.
9. Open the water shut-off valve in the return piping to the unit.
10. Open the water supply shut-off valve to the unit to refill.
11. After shell is full press **LOW WATER LEVEL – RESET** to reset the low water cutoff.
12. Press **CLEAR** to reset the **FAULT** LED and clear the displayed error message.
13. Set the **Enable/Disable** switch to **Enable**. The unit is now ready for operation.

6.5 Water Temperature Fault Test

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

1. Start the unit in the normal operating mode and allow the unit to stabilize at its setpoint.
2. On the Automatic Reset Over-Temperature switch, note the current setting, then:
 - a. Press the **Set** button two times, to activate a setting change.
 - b. Use the **Down** arrow to lower the setting to a temperature **below** the Outlet temperature displayed on the Controller's front face (see Figure 6-6).
 - c. Press the **Set** and **Down** arrow at the same time to save that temperature setting.

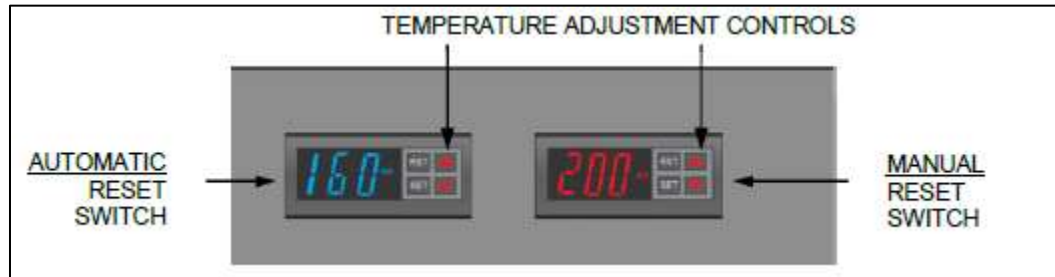


Figure 6-5: Over Temperature Limit Switches

NOTE: If the Controller's is not configured to display outlet temperature, go to **Advanced Setup → Unit → Front Panel Configuration** and set **Upper-Right Display** to **Water Outlet**.

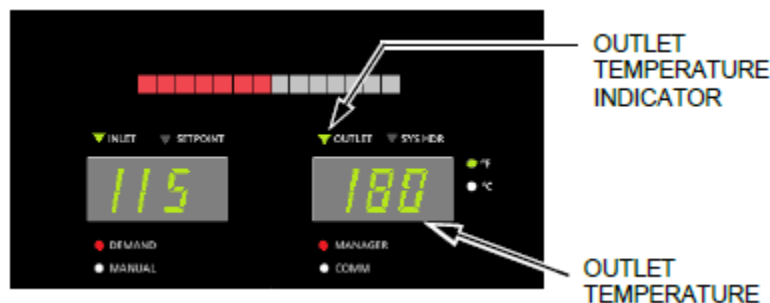


Figure 6-6: Edge Controller Front Face

3. Once the Automatic Reset Over-Temperature switch setting is approximately just below the actual outlet water temperature, the unit should shut down, the **FAULT** indicator should start flashing, and a **High-Water Temp Switch Open** fault message should be displayed. It should not be possible to restart the unit.
4. Repeat Step 2 to return to the Automatic Reset switch; but press **Up** arrow to return to its original setting.
5. The unit should start once the setting is above the actual outlet water temperature.
6. Repeat steps 1 – 4 on the Manual Reset switch. However, unlike the Automatic Reset switch, the unit will not restart automatically when the original temperature is restored. You must press the **RST** (Reset) button to restart the unit.

6.6 Interlock Tests

The unit is equipped with three interlock circuits, connected to the I/O board's connector strip J6, labeled **Remote Interlock**, **Delayed Interlock 1** and **Delayed Interlock 2** (see Section 2.10.1). 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.

6.6.1 Remote Interlock Test

1. Remove the cover from the I/O Box and locate the **Remote Interlock** terminals on connector strip J6.
2. Go to **Main Menu → Diagnostics → Manual Run** and enable **Manual Mode**.
3. Set the valve position **between 25% and 30%** using the + (Plus) and – (Minus) controls.
4. If there is a jumper across the **Remote Interlock** 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.
5. The unit should shut down and the Controller should display **Interlock Open**.
6. Once the interlock connection is reconnected, the **Interlock Open** message should automatically clear and the unit should restart.

6.6.2 Delayed Interlock Test

1. Remove the cover from the I/O Box and locate the **Delayed Interlock 1** terminals on connector strip J6.
2. Go to **Main Menu → Diagnostics → Manual Run** and enable **Manual Mode**.
3. Set the valve position between 25% and 30% using the + (Plus) and – (Minus) controls.
4. If there is a jumper across the **Delayed Interlock 1** terminals, remove one side of the jumper. If the interlock is connected to a proving switch of an external device, disconnect one of the wires leading to the proving switch.
5. The unit should shut down and display a **Delayed Interlock Open** fault message. The **FAULT** LED should be flashing.
6. Reconnect the wire or jumper removed in step 5 to restore the interlock.
7. Press the **CLEAR** button to reset the fault
8. The unit should start.
9. Repeat the above for the **Delayed Interlock 2** terminals.

6.7 Flame Fault Test

Flame faults can occur during ignition or while the unit is already running. To simulate each of these fault conditions, proceed as follows:

1. Set the Controller's **Enable/Disable** switch to **Disable**.
2. Go to **Main Menu → Diagnostics → Manual Run** and enable **Manual Mode**.
3. Set the valve position **between 25% and 30%** using the + (Plus) and – (Minus) controls.
4. Close the gas train's Manual Shutoff valve located between the Safety Shut-Off Valve (SSOV) and the Air/Fuel Valve, as shown on Figure 6-4, above.
5. It may be necessary to jump out the High Gas Pressure switch.

6. Set the Controller's **Enable/Disable** switch to **Enable** to start the unit.
7. The unit should purge and light the Pilot flame and then shut down after reaching the main Burner Ignition cycle and display **Flame Loss During Ign.**
8. Open the Manual Shutoff valve closed in step 4 and press the **CLEAR** soft key.
9. Restart the unit and allow it to prove flame.
10. Once flame is proven, close the Manual Shutoff valve located between the SSOV and the Air/Fuel Valve (see Figure 6-4, above).
11. The unit should shut down and execute an IGNITION RETRY cycle:
 - The unit executes a 15-second shutdown purge cycle and display **Wait Fault Purge.**
 - The unit executes a 30 second re-ignition delay and displays **Wait Retry Pause.**
 - The unit executes a standard ignition sequence and displays **Wait Ignition Retry.**
 - Since the Manual Shutoff valve is still closed, the unit will fail the ignition retry; it will shut down and display **Flame Loss During Ign** following IGNITION RETRY cycle.
12. Open the manual gas valve closed in step 11.
13. Press the **CLEAR** button. The unit should restart and fire.

6.8 Air Flow Fault Tests-Blower Proof & Blocked Inlet Switches

These tests check the operation of the **Blower Proof** switch and **Blocked Inlet** switch.

6.8.1 Blower Proof Switch Test



Figure 6-7: Blower Proof & Blocked Inlet Switch Locations

1. Set the Controller's **Enable/Disable** switch to **Disable**.
2. Remove the front panels to gain access to the Blower Proof Switch, shown above.
3. Use a Phillips head screw driver to remove the front cover from the switch to reveal the switch setting indicator dial (0.6 in the figure below) .

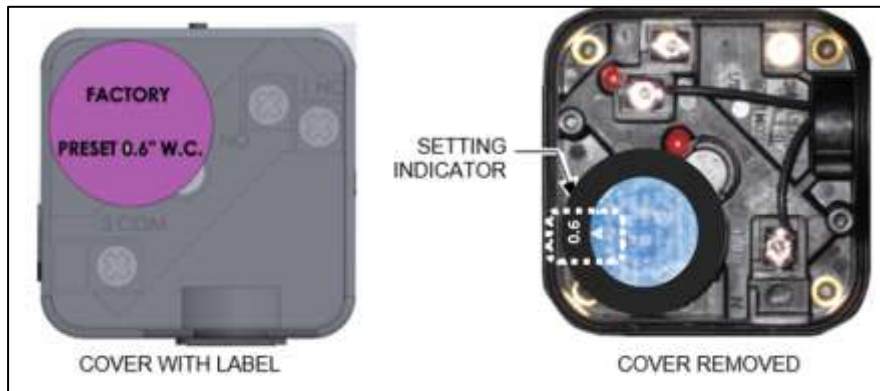


Figure 6-8: Blower Proof Switch

4. Set the Controller's **Enable/Disable** switch to **Enable** and wait for the Water Heater to go into the Purge sequence.
5. After about 5 seconds, with air flowing into the combustion chamber, slowly turn the dial clock-wise (to higher value) until the unit trips off with an **Air Flow Fault During Purge** message. Optionally, attach a manometer and measure the setting at the trip point.
6. After the Water Heater shuts down, reset the dial indicator to its original position, shown on the switch cover label, then replace the switch cover.
7. Reset the Water Heater.

6.8.2 Blocked Inlet Switch Test

This test will be run in simulated fire mode, with the Blocked Inlet switch isolated from the rest of the control circuitry.

1. Set the Controller's **Enable/Disable** switch to **Disable**.
2. Remove the air filter (see Figure 6-7, above).
WARNING: THE BLOWER SUCTION IS VERY STRONG AND CAN PULL NEARBY OBJECTS INTO THE FAN BLADES!
3. Turn off the gas supply ball valve to the unit and then complete the following steps:
 - a) Use jumper wires to jump out the Low Gas Pressure switch and Blower Proof switch.
 - b) Remove the black connector boot from the Flame Detector.
 - c) Create a connector as shown below and connect it to the Flame Detector's black connector boot. Keep the alligator clip away from bare metal parts until step 5b.

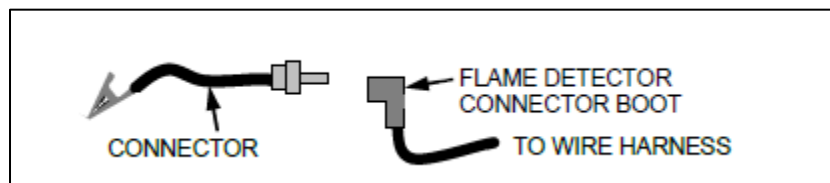


Figure 6-9: Connecting the Flame Signal Generator

4. Go to **Diagnostics** → **Manual Run** and enable the **Manual Mode** control.
5. Ramp the Water Heater up to 100% fire rate and then set the Controller's **Enable/Disable** switch to **Enable**.

6. When the Controller gets into the ignition phase, it will show **Ignition Trial**. At that point attach the alligator clip (Figure 6-9) to any bare metal surface or ground. The Controller displays **Flame Proven** and begins to ramp up to 100% fire rate. Note that no gas or flame is present in the Water Heater at this time.
7. Wait for the unit to ramp up to at least 90% before continuing.
8. Cover the combustion air inlet opening with a solid, flat object, such as a piece of thick plywood or a thick metal plate.
9. The unit should shut down and display **Airflow Fault During Run**. This step confirms proper operation of the Blocked Inlet switch.
10. Remove cover from air inlet opening and reinstall the Combustion Air Duct or air filter.
11. Remove jumper wires installed in step 3 and replace the black connector boot on the Flame Detector.
12. Press the **CLEAR** button. The unit should restart.

6.9 SSOV Proof of Closure Switch Check

The SSOV (shown in Figure 6-7) contains the **Proof of Closure** switch. The **Proof of Closure** switch circuit is checked as follows:

1. Set the Controller's **Enable/Disable** switch to **Disable**.
2. Go to **Main Menu → Diagnostics → Manual Run** and enable **Manual Mode**.
3. Set the valve position **between 25% and 30%** using the + (Plus) and – (Minus) controls.
4. Loosen the SSOV cover screw and remove cover to access wiring connections.
5. Disconnect wire #1304 from the SSOV to “open” the Proof of Closure switch circuit.
6. The unit should fault and display **SSOV Switch Open**.
7. Replace wire #1304 and press the **CLEAR** button.
8. Set the Controller's **Enable/Disable** switch to **Enable** to start the unit.
9. Remove the wire again when the unit reaches the purge cycle and **Purging** is displayed.
10. The unit should shut down and display **SSOV Fault During Purge**.
11. Replace the wire on the SSOV and press the **CLEAR** button. The unit should restart.

6.10 Purge Switch Open During Purge

The **Purge** switch (and **Ignition** switch) is located on the Air/Fuel Valve. To check the switch:

1. Set the Controller's **Enable/Disable** switch to **Disable**.
2. Go to **Main Menu → Diagnostics → Manual Run** and enable **Manual Mode**.
3. Set the valve position **between 25% and 30%** using the + (Plus) and – (Minus) controls.
4. Remove the Air/Fuel Valve cover by rotating the cover counterclockwise to unlock it.
5. Remove one of the two wires (#1609 or #1610) from the Purge switch (Figure 6-11).
6. Set the Controller's **Enable/Disable** switch to **Enable** to start the unit.
7. The unit should begin its start sequence, then shut down and display **Prg Switch Open During Purge**.
8. Replace wire on the Ignition switch and press **CLEAR** button. The unit should restart.



Figure 6-10: Air/Fuel Valve Cover Location

6.11 Check Ignition Switch Open During Ignition

The **Ignition** switch (and the **Purge** switch) is located on the Air/Fuel Valve. To check the switch, proceed as follows:

1. Set the Controller's **Enable/Disable** switch to **Disable**.
2. Go to **Main Menu → Diagnostics → Manual Run** and enable **Manual Mode**.
3. Set the valve position **between 25% and 30%** using the + (Plus) and – (Minus) controls.
4. Remove the Air/Fuel Valve cover (Figure 6-10, above) by rotating counterclockwise.
5. Remove wire #1611 or #1612 from the Ignition switch (Figure 6-11).
6. Set the Controller's **Enable/Disable** switch to **Enable** to start the unit.
7. The unit begins its start sequence and then shut down and display **Ign Switch Open During Ignition**.
8. Replace wire on the Ignition switch and press **CLEAR** button. The unit should restart.

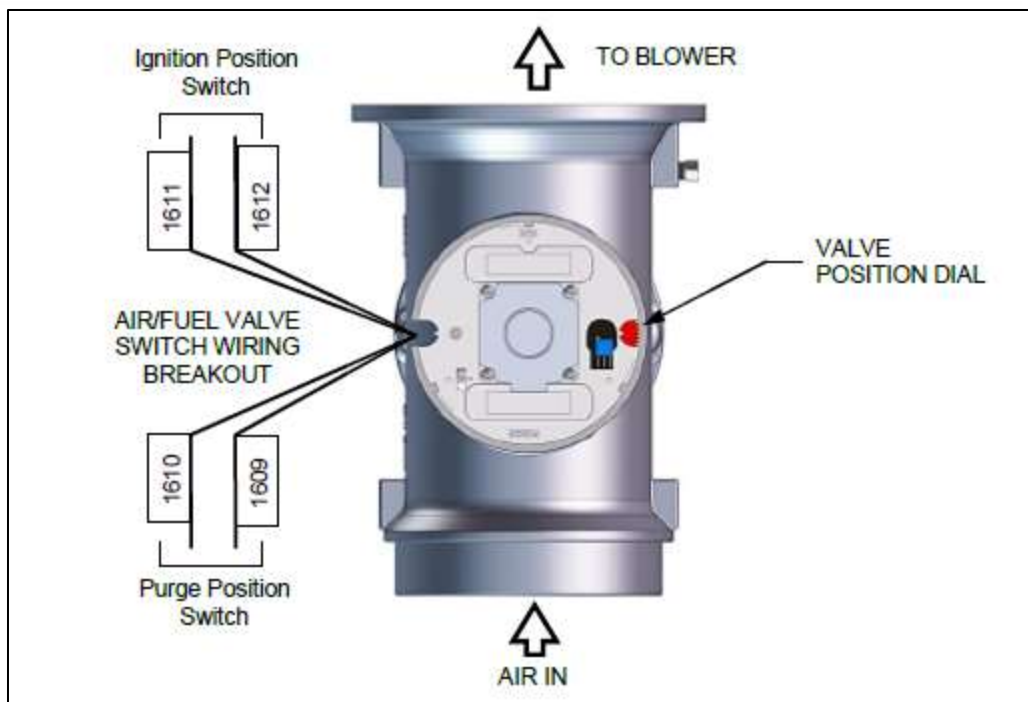


Figure 6-11: Air/Fuel Purge and Ignition Locations

6.12 Safety Pressure Relief Valve Test

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

SECTION 7: MAINTENANCE

7.1 Maintenance Schedule

All Centurion Water Heaters 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 the table below. 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.
- Disconnect power supply by turning off the service switch and AC supply circuit breaker.
- Shut off gas supply at the manual shut-off valve provided with the unit.
- Allow the unit to cool to a safe water temperature to prevent burning or scalding.

Maintenance Schedule					
SEC	ITEM	6 MOS. *	12 MOS.	24 MOS.	LABOR TIME
7.2	Igniter-Injector	Inspect	Inspect, replace if necessary	Replace	15 mins.
7.3	Flame Detector	Inspect	Inspect, replace if necessary	Replace	15 mins.
7.4	O ₂ Sensor inspection and calibration	Inspect	Inspect/Clean/Calibrate		15 mins.
5.4	Combustion Calibration	Check	Check		1 hr.
7.5	Testing of Safety Devices		See ASME CSD-1 Chart		45 mins.
7.6	Burner			Inspect	2 hrs.
7.8	Condensate Drain Trap	Inspect	Inspect, Clean & Replace Gaskets	Inspect, Clean & Replace Gaskets	30 mins.
7.8	Air Filter		Clean	Replace	15 mins.
7.9	Isolation Valve		Check		
7.10	Recirculation Pump		Check		
7.12	Periodic Testing	Routine verification of functionality, various schedule			

* Only performed after initial 6-month period after initial startup.

The following maintenance kits are available from PVI. All kits include a Technical Instruction Document (TID) with instructions for performing the tasks specified.

Maintenance Kits			
Model	Kit#	Parts Serviced/Replaced	Doc Name
12 Month Maintenance Kit			
CEN 2000/1600	58025-25	Ignitor, Flame Rod, Condensate trap O rings	TID- 0236
24 Month Maintenance Kit			
CEN 2000/1600	58025-26	Burner & Blower gaskets, LWCO, air filter replacement	TID- 0237
	58025-27	Burner & Blower gaskets, LWCO, air filter <i>cleaner</i>	

7.2 Igniter-Injector

The igniter-injector should be ***inspected*** annually and ***replaced*** at least every 24 months of operation, sooner if there is evidence of substantial erosion or carbon build-up. Parts and instructions are included in the CEN 2000/1600 12 Month (P/N **58025-25**) and 24 Month (P/N **58025-26** and **58025-27**) Maintenance Kits.

The igniter-injector may be hot; therefore, care should be exercised to avoid burns. It is easier to remove the igniter-injector from the unit after the unit has cooled to room temperature. To inspect/replace the Igniter:

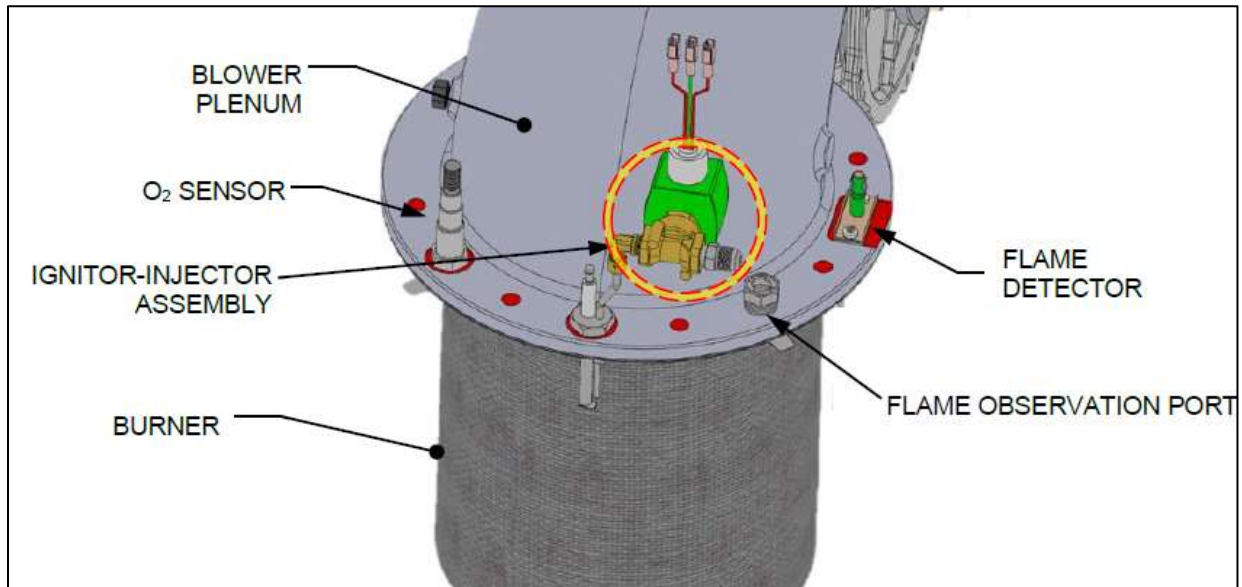


Figure 7-1: Igniter-Injector & Flame Detector

Note that during installation, use the number of indexing (clocking) washers necessary that, when tight, the gas injection tube is positioned as shown below.

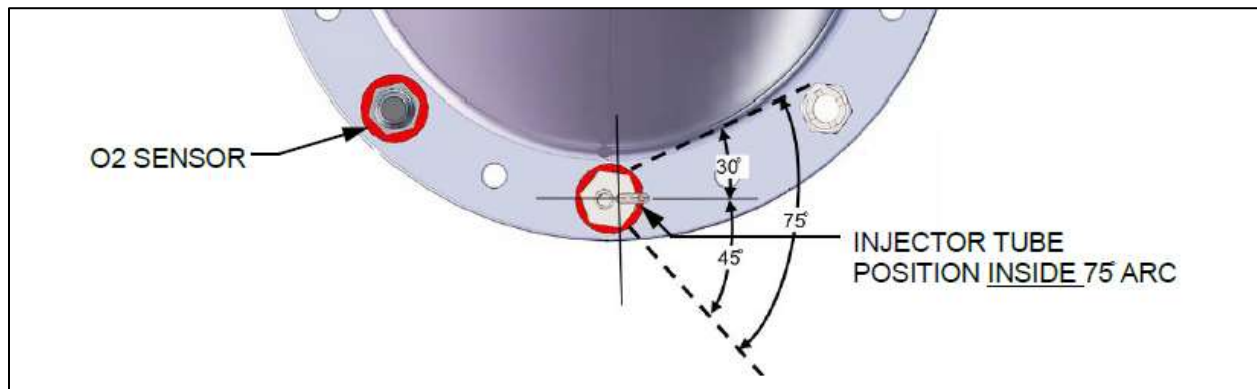


Figure 7-2: Igniter-Injector Orientation

7.3 Flame Detector

The Centurion Flame Detector (kit P/N **24356-1**) is located on the burner plate at the top of the unit (see Figure 7-1). The flame detector should be inspected every 12 months and replaced every 24 months, or sooner if damaged or warped. Note, it may be hot; allow the unit to cool sufficiently before removing the flame detector.

This part and instructions are included in the CEN 2000/1600 12 Month (P/N **58025-25**) and 24 Month (P/N **58025-26** and **58025-27**) Maintenance Kits. Be sure to use the current model flame detector, included in the maintenance kit; some older flame detectors are shaped differently and may not function properly.

7.4 O₂ Sensor Maintenance

The Lean Oxygen Sensor (P/N **61026C**) should be cleaned and inspected every 12 months. It is not included in any of the 12- or 24-month maintenance kits. It is located on the burner plate at the top of the unit. It may be hot, so allow unit to cool sufficiently before removing or replacing it.

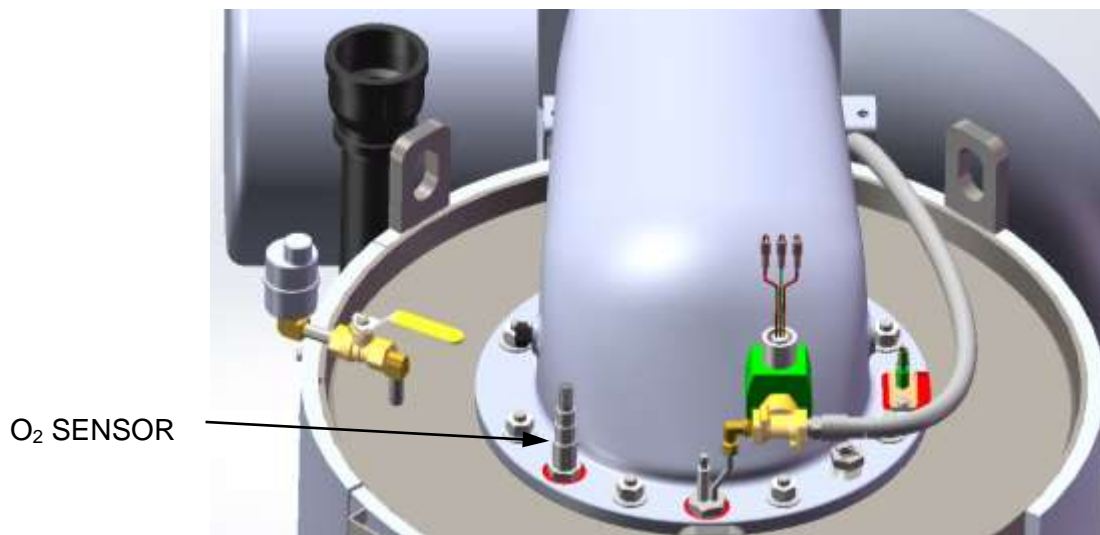


Figure 7-3: O₂ Sensor Mounting Location

Lean O₂ Sensor Maintenance

1. Set the Enable/Disable switch on the Edge Controller to **Disabled**.
2. Remove the top enclosure cover from the unit.
3. Disconnect O₂ sensor lead wire by pushing the release tab and pulling connector apart.
4. Next, loosen and remove the O₂ sensor and crush washer from the burner plate using a 15/16" open-end wrench.
5. Thoroughly inspect the O₂ sensor. If eroded, the sensor should be replaced. Otherwise clean the sensor with a fine emery cloth.

NOTE: It is recommended to perform O₂ Sensor calibration before replacing the O₂ Sensor. Go to **Calibration**→**Input/Output**→**O₂ Sensor** (see *SECTION 9: O₂ TRIM OPERATION*).

6. Reinstall the O₂ sensor and crush washer on the burner plate.
7. Reconnect the sensor lead wire.
8. Reinstall the top enclosure cover on the unit.

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 log book.

7.6 Burner Inspection

The burner assembly should be **inspected** every 24 months to ensure that all components are intact and functioning as designed. This requires the replacement the burner gasket and blower and gas train O-Rings, which are included in the 24 Month Maintenance Kit. If the burner is not fully intact, it must be **replaced** as soon as possible.

The burner assembly is located at the top of the unit's heat exchanger. The burner assembly may be hot. Therefore, allow the unit to cool sufficiently before removing the burner assembly. Burner inspection parts are included all 24 Month Maintenance Kit. Instructions are in the Technical Instruction Documents (TID) included with the kit.

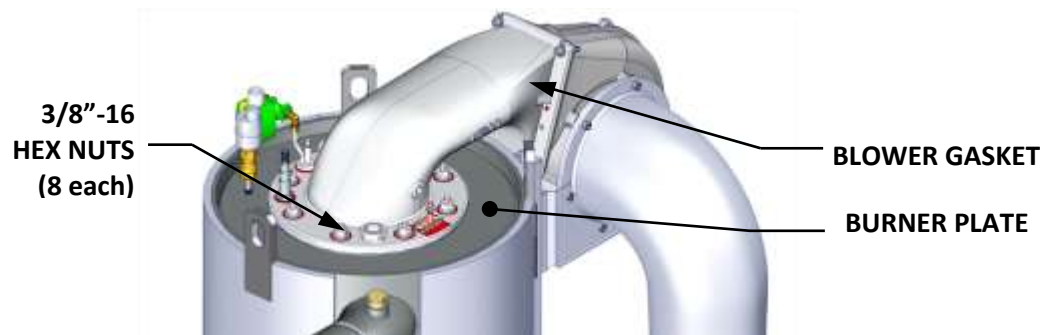


Figure 7-4: Burner Assembly Mounting Details

7.7 Condensate Drain Trap

All Centurion Water Heaters contain a condensate trap (P/N 24441C), located external to the unit, attached to the exhaust manifold's drain at the rear of the unit. This trap must be **inspected** for leaks and blockages, **cleaned** to ensure that the float is free to move, and condensate flows normally, and the O-Ring (P/N 84017C included in all 24 Month Maintenance Kits) replaced if it is worn or damaged. In addition, you must ensure the vent (under the removable cover) is free and clear of obstructions.

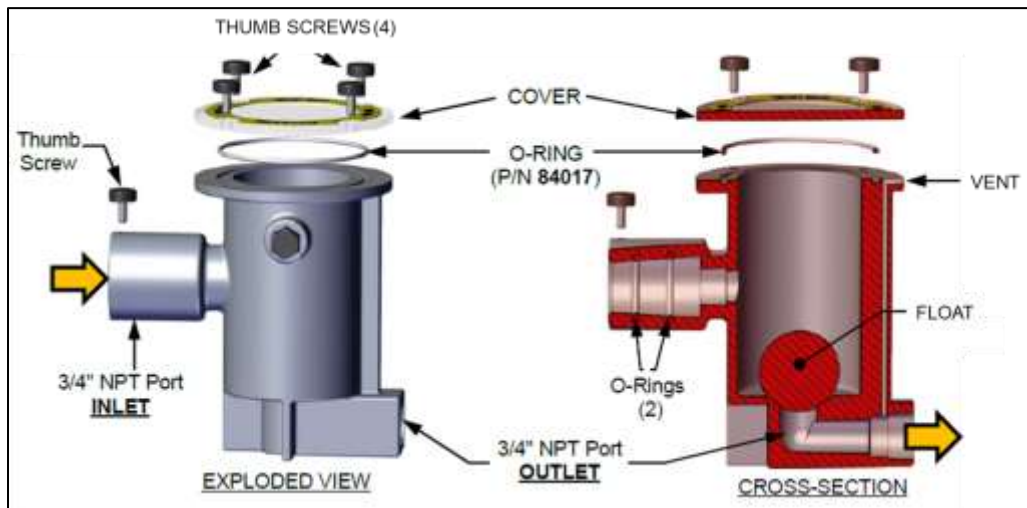


Figure 7-5: External Condensate Trap, Cross-Section & Exploded View

If your system includes a condensate neutralizer, the active ingredient must be periodically replaced.

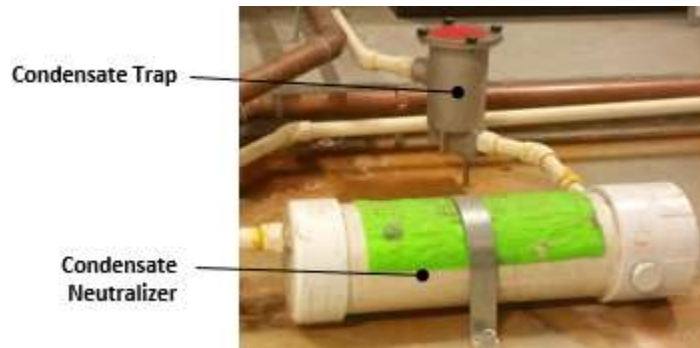


Figure 7-6: Condensate Trap and Neutralizer

7.8 Air Filter Cleaning and Replacement

The Water Heater's air filter should be **Cleaned** every 12 months, and **Replaced** after 24 months if it shows signs of deterioration. However, if still in good condition you can order a 24 Month Maintenance kit with air filter cleaning kit.

NOTE: Failure to clean or replace the air filter may affect stable combustion, result in less efficient operation, and may result in combustion reliability issues.

All 24 Month Maintenance Kits include one of two parts:

- **An Air Filter Cleaning Kit** – Appropriate if the filter is intact.
- **New Air Filter** – Necessary if the filter is deteriorated or damaged.

Check the table below to find the part number of the kit appropriate for your site. Instructions are included in the TID that accompanies the kit.

12 Month Maintenance Kit: 58025-25
24 Month Maintenance Kit w/ air filter replacement: 58025-26
24 Month Maintenance Kit w/ air filter cleaner: 58025-27

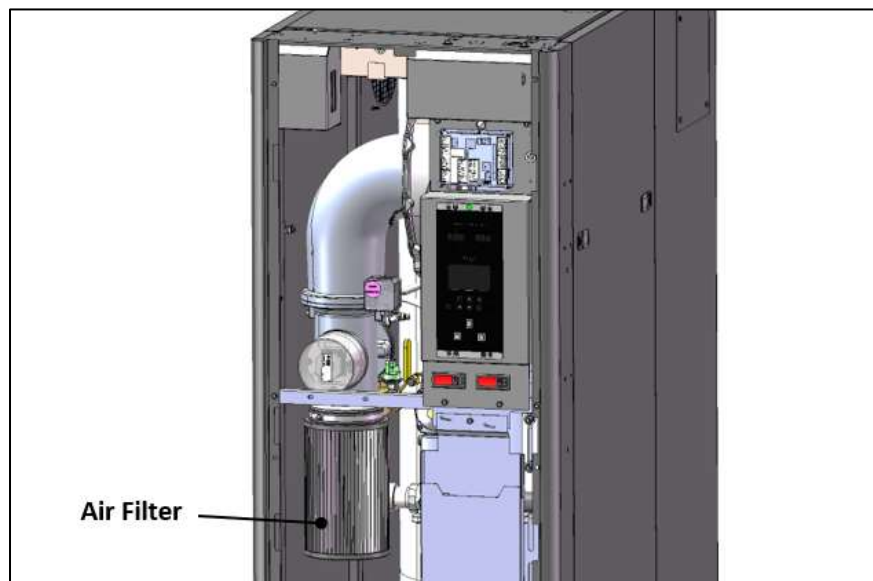


Figure 7-7: Air Filter Location

7.9 Shutting Water Heater Down for Extended Period (One Year or More)

1. Set Enable/Disable switch on the front panel to the **Disable** position.
2. Disconnect AC power from the unit.
3. Close the water supply and return valves to isolate Water Heater.
4. Close external gas supply valve.
5. Open relief valve to vent water pressure.
6. Open the drain valve and drain all water from the unit.
7. 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 6 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!

Failure to drain all water may cause heat exchanger tubes to crack and fail.

7.9.1 Returning The Water Heater to Service After Shutdown

1. Review installation requirements included in Section 2.
2. Inspect all piping and connections to the unit.
3. Inspect exhaust vent and air inlet duct work (if applicable).
4. Perform initial startup per Section 5.
5. Follow the Safety Device Testing instructions in Section 6.

7.10 Recommended Periodic Testing

⚠ WARNING!

Periodic testing of all Water Heater controls and safety devices is required to ensure they continue to operate as designed. Precautions must be taken while tests are being performed to protect against bodily injury and property damage. The owner or user of an automatic Water Heater system should set up a formal system of periodic preventive maintenance and testing. Tests should be conducted on a regular basis and the results recorded in a logbook.

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
Firing Rate Control	Semi-Annually	Service Tech	Verify factory settings
	Annually	Service Tech	Check with combustion calibration test equipment (see Section 5.2) and the O ₂ sensor (Section 7.4).
Flue, vent, stack and intake air duct	Monthly	Operator	Visually inspection condition and check for obstructions
Spark Igniter-Injector	Weekly	Operator	See Section 7.2: <i>Ignitor-Injector</i> in this guide.
Air/Fuel Valve position	Weekly	Operator	Check position indicator dial. See Section 4.2.
SSOV Leakage test	Annually	Service Tech	Check for leakage in accordance with the SSOV manufacturer's (Siemens) recommendations.
Flame failure	Weekly	Operator	Close manual gas shutoff valve and check safety shutdown. See Section 6.7.

Recommended Periodic Testing			
ITEM	FREQUENCY	ACTION BY	REMARKS
Flame signal strength	Weekly	Operator	Check flame strength in the Edge Controller's <i>Unit Status</i> screen.
Low water level cut off and alarm	Weekly	Operator	See Section 6.4: <i>Low Water Level Fault Test</i> .
Slow drain test	Semi-Annually	Operator	Perform a slow drain test in accordance with ASME Water Heater and Pressure Vessel Code, Section IV.
High water temp. safety control test	Annually	Service Tech	See Section 6.5: <i>Water Temperature Fault Test</i> .
Operating controls	Annually	Operator	See Section SECTION 3: <i>Edge Controller Operation</i> .
Low air flow	Monthly	Operator	See Section 6.8 and 7.8.
High and low gas pressure interlocks	Monthly	Operator	See Sections 6.2 and 7.3.
Air/Fuel Valve purge position switch	Annually	Service Tech	See Section 6.10.
Air/Fuel Valve ignition position switch	Annually	Service Tech	See Section 6.11.
Safety valves	As required	Operator	Check per A.S.M.E. Water Heater and Pressure Vessel Code, Section IV.
Inspect burner components	Semi-Annually	Service Tech	See Section 7.6: <i>Burner Inspection</i> .
Condensate Trap	Semi-Annually	Operator	See Section 7.7: <i>Condensate Drain Trap</i> .
Oxygen (O ₂) Level	Monthly	Operator	Verify oxygen level is between 3% and 8% during Water Heater operation.

7.11 Recommended Spare Parts

Recommended Emergency Spare Parts	
DESCRIPTION	Part Number
VAC Blower Replacement Kit (460V)	58063-1
VAC Blower Replacement Kit (208V)	58063-2
SSOV Actuator/Regulator Combo - Used on: <ul style="list-style-type: none"> ALL FM gas trains Downstream SSOV on DBB gas trains 	64048
SSOV Actuator <u>Without</u> Proof of Closure Switch - Used on: <ul style="list-style-type: none"> Upstream SSOV on DBB gas trains 	27086-1
Actuator Replacement Kit: SSOV with P.O.C. Switch Kit	27086-2
Actuator Replacement Kit: SSOV with Regulator, POC Switch & Damping Orifice	64106
Pilot Solenoid Valve, 1/4" NPT FRU Kit	58089
Temperature Switch - Manual Reset	64155-1
Ignitor Rod FRU Kit (component of Flame Rod Assy. 66026)	58023

Optional Spare Parts	
DESCRIPTION	PART NUMBER
Edge Controller	64142
Burner	46063
Oxygen Sensor	61026

SECTION 8: WATER HEATER MANAGEMENT

The on-board Water-Heater Management system (WHM) feature is integrated in the Edge Controller, designed to stage and coordinate multiple Centurion Water Heaters while maximizing operational efficiency. The WHM software code resides in each Edge Controller that is part of the system. The WHM system can control up to sixteen (16) Water Heaters in parallel. Each Water Heater controlled by the WHM system must be equipped with an actuator-controlled Sequencing Isolation Valve (P/N **92154C**). This valve is installed on the outlet of each Water Heater in the WHM network (see Figure 8-1, below).

NOTE: Some of the descriptions and procedures in this section may duplicate previous sections of this manual. This is done to organize all WHM-related information into a single section. It is assumed that the user is familiar with the basic Edge Controller’s menu navigation used throughout this manual.

8.1 General Description

The Edge Controller’s Water Heater Management system (WHM) is designed to ensure that all Water Heaters in the system operate at maximum efficiency. This is accomplished by monitoring the Air/Fuel Valve position (VP) of all Water Heaters that have their Sequencing Isolation Valves open.

Units with open Sequencing Valves are called enabled units. Units with closed Sequencing Valves are called disabled units. Units which are unable to function, due to a fault or user intervention, are called offline units. When there is minimal or no demand for hot water, the Sequencing Valve for one unit will be open. As system load increases, the WHM will fire up and open the Sequencing Valves on additional heaters.

A simplified block diagram of multiple Water Heaters connected to a WHM is shown below.

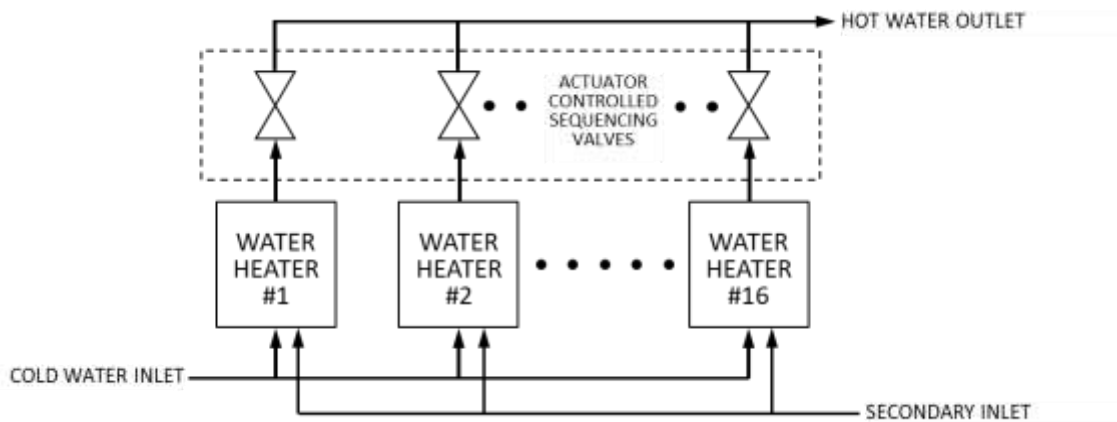


Figure 8-1: Simplified Block Diagram - Water Heater Management (WHM)

8.2 WHM Principles of Operation

The WHM system communicates with the plant Water Heaters via a RS485 network utilizing Modbus RTU protocol (8-bit, 9600 baud, no parity). Multiple baud rates (9600, 19200, 38400, 57600) options are available in WHM Cascade menu. All Modbus networks are implemented using a “Manager” / “Client” scenario. Only one unit must be configured as a Manager and other units must be set as Clients. Any unit can be set as a Manager to control the WHM system.

The WHM Manager monitors the Air/Fuel Valve position (VP) of all enabled units. When this valve position (% open) exceeds a user-selectable limit (**Next On Valve Pos**), the WHM will open the Sequencing Valve of another Water Heater in the system. Conversely, when the valve positions of all enabled units have dropped below a different user-selectable limit (**Next Off Valve Pos**) threshold, the WHM Manager will close the Sequencing Valve on a unit. The philosophy behind this approach is to maintain the fire rates (Air/Fuel Valve % open) at a level that maximizes heater efficiency.

In addition to collecting Air/Fuel Valve position data, the controlling Manager also monitors the total accumulated operating time for each unit on the system and attempts to balance the system so that all units operate for approximately the same number of hours.

8.3 WHM Features

8.3.1 Valve Feedback

The Valve Feedback feature is designed to confirm that the Sequencing Isolation Valve has successfully executed either a Valve-Open or Valve-Close command from the Edge Controller.

The Valve Feedback signal from the Sequencing Isolation Valve is connected to the Edge Controller via the I/O box. When the Edge Controller issues either a Valve-Open or Valve-Close command to the valve, the Valve Feedback signal is monitored to confirm that the Valve has successfully opened or closed. If there is a mismatch between the Valve Feedback signal and the Valve-Open or Valve-Close command that lasts longer than specified in “Valve Feedback Timer”, a fault is invoked.

This feature can be enabled or disabled in the Valve Feedback parameter (see **Advanced Setup → WHM Cascade → Operating Controls → Sequencing Control Configuration**).

8.3.2 Valve Supervisor

This feature continually monitors the valve feedback (open or closed) to confirm operation. If the valve supervisor detects an anomaly, the following faults/warning are displayed :

1. If the valve is stuck open, it displays the fault message VALVE STUCK OPEN but continues operation (do not shut the unit down).
2. If the valve is stuck closed, it shuts down the unit and displays the fault message VALVE STUCK CLOSED.

8.3.3 Temperature Sensor Calibration

The Temperature Sensors screens allows you calibrate the unit's temperature sensors to achieve optimal performance. Complete the following to calibrate the temperature sensors.

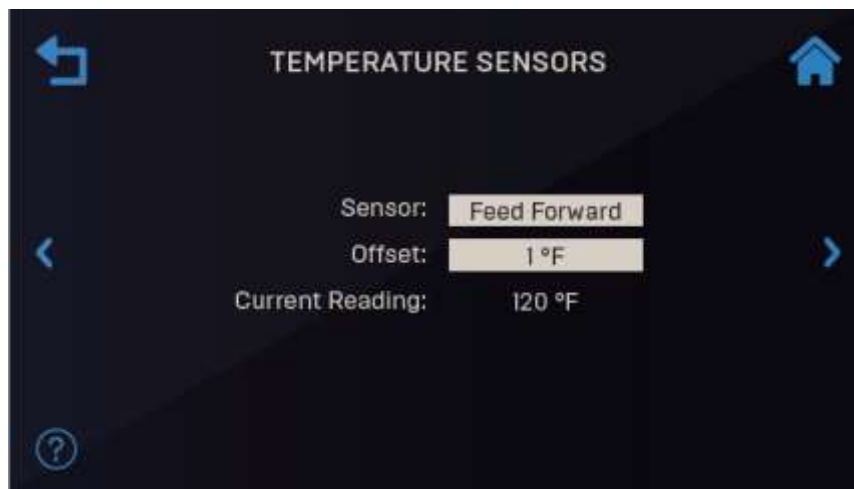


Figure 8-2: Temperature Sensors Screen

1. Go to: **Main Menu → Calibration → Input/Output → Temperature Sensors.**
2. Press the Sensor parameter and select the temperature sensor you want to calibrate. The following sensors are available for calibration:
 - Feed Forward
 - Lower Inlet
 - Air Inlet
 - Outside Temp
 - Exhaust
 - Outlet
3. The selected sensor's current reading appears in the Current Reading field.
4. If there is an independent way to measure the temperature, and it differs from the Current Reading, enter an appropriate value in the Offset parameter.

8.3.4 Manual Mode Password Required

To prevent unauthorized or inadvertently setting the unit, entering a valid password is required to set the Edge in Manual Mode. Any level password will enable Manual Mode.

8.3.5 Auto-Manager Transfer

The Auto-Manager Transfer feature, once enabled, automatically transfers WHM Manager functionality to a new unit if the current WHM Manager fails or loses power.

To use this feature (default = Disabled), go to: **Advanced Setup → WHM Cascade → Cascade Configuration** on the unite designated as the WHM Manager and set **Auto-Manager Transfer** to **Enabled**, then choose the address of the backup unit in the **Backup Manager Addr** parameter. You can also specify a delay before transferring manager functionality in the **Auto-Manager Timer** parameter.

8.3.6 Run Hours and Run Cycles

Run hours and run cycles are monitored to select the Lead unit and Lag unit (next on unit) in a WHM Cascade mode. Run hours and run cycles can be increased to match other units in an existing plant to make sure that the unit is properly sequenced. Run hours and run cycles can only be increased but cannot be decreased. Once entered, the changes made will be permanent and this feature will not allow changing to the previous value.

Only PVI personnel are permitted to change this menu item. To increase the **Run Hours** or **Run Cycles**, go to **Main Menu → Advanced Setup → Unit → Unit Settings → Run Hours.**

8.3.7 High Temperature Governor

The High Temperature Governor is a feature that aggressively prevents the outlet temperature from exceeding the “Temperature High Limit”. The High Temperature Governor is independent of the system PID and Feed-Forward control methodology and independently modulates the Valve Position (Fire Rate) if the outlet temperature dangerously approaches the **Temperature Hi Limit** parameter.

This feature has 5 separate temperature bands for more precise control.

This feature is enabled by the **TEMP GOV** parameter in **Main Menu → Advanced Setup → Performance → Temperature Control → FFWD Settings**. Once enabled, the 5 “governor” items, **GOV Limit-5** to **GOV Limit-15** are available. When the Outlet Temperature nears the value of the **Temperature Hi Limit** parameter (**Advanced Setup → Performance → Temperature Control → Temperature Conformance**) the effective Fire Rate will be reduced by the value entered in **GOV Limit-5** through **GOV Limit-15**.

8.4 WHM Status Displays

The following WHM status information will be displayed to inform the user of critical WHM real-time operating conditions:

Once a unit is defined as the WHM Manager, the green Manager light appears on the Controller’s face and the following information appears on the WHM Cascade Status screen:

- MANAGER-DISABLED** – The Manager has been disabled and is not available
- MANAGER-STANDBY** – The Manager is “Cycled Off” and is available to be lit off
- MANAGER-IGNITED** – The Manager is ignited

On units defined as WHM Clients, the following information will be displayed:

- CLIENT-DISABLED** – The Client has been disabled and is not available
- CLIENT-STANDBY** – The Client is “Cycled Off” and is available to be lit off
- CLIENT-IGNITED** – The Client is ignited

8.5 Water Heater Management Alternating Status Displays

On both WHM Manager units, the following status information will alternate, and be displayed on the WHM Cascade Status screen:



Figure 8-3: WHM Cascade Status Screen

The following messages may appear on this screen:

- FAILSAFE ACTIVE** – The Client Failsafe Mode has been activated
- All Heaters On** – All available heaters are ignited
- All Heaters Off** – All available heaters are off
- Enabling First** – The first heater is allowed to ignite and its valve is opened
- Enabling Next** – The next heater is allowed to ignite and its valve is opened
- Wtr Htr Inactive** – This Client unit is inactive; its valve is closed and can't ignite
- Wtr Heatr Active** – This Client unit is active; its valve is opened and it can ignite
- REMOTE SIG FAULT** – Remote signal fault
- WHMS FAILSAFE** – WHMS is in Failsafe Mode

8.6 WHM Parameters

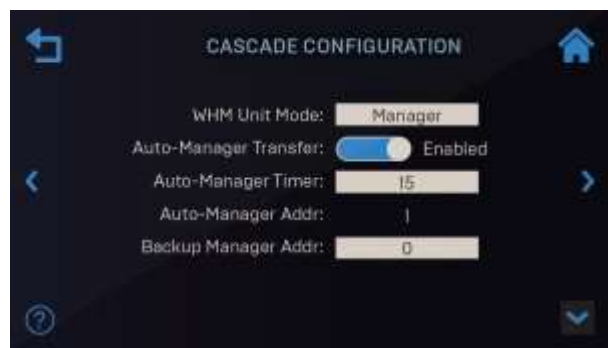
The WHM parameters are under **Advanced Setup → WHM Cascade**. Many of these are preset at the factory and cannot be altered by the user.

NOTE: Some parameters will not appear on screen if they are not enabled.

WHM Cascade → Cascade Configuration Parameters			
Menu Item Display	Available Choices or Limits		Default
	Minimum	Maximum	
WHM Unit Mode	Off, WHM Client, WHM Manager		Off
Auto-Manager Transfer	Enable, Disable		Disable
Auto-Manager Timer	10 sec.	120 sec.	30 sec.
Auto-Manager Addr	0	16	Read Only
Backup Manager Addr	0	16	0



WHM Unit Mode = WHM Client

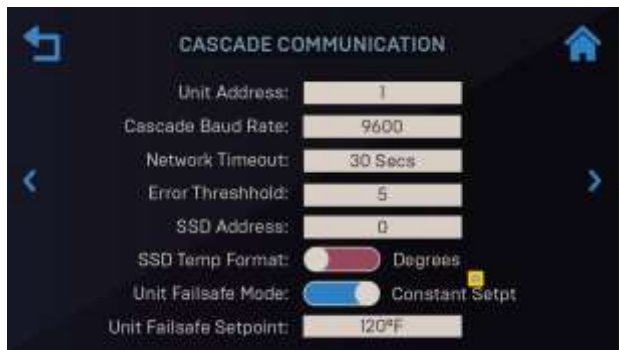


WHM Unit Mode = WHM Manager

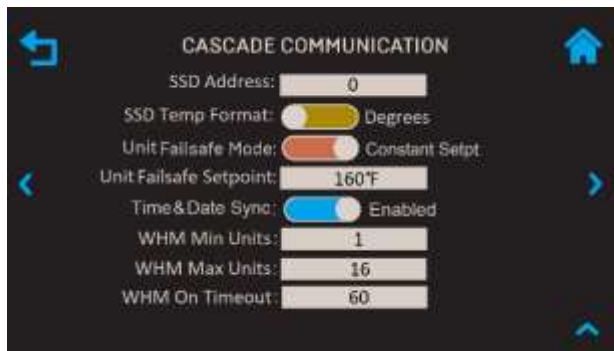
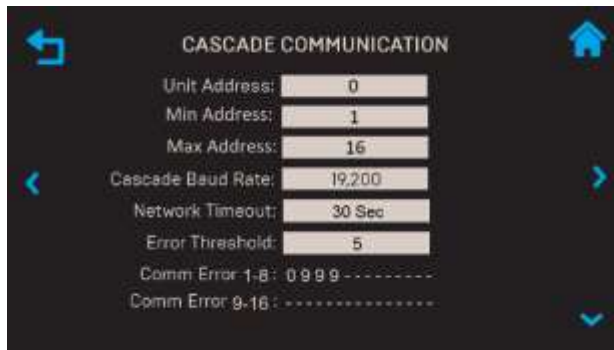
Figure 8-4: Cascade Configuration Screens



WHM Cascade → Cascade Comm Parameters			
Menu Item	Available Choices or Limits		Default
Display	Minimum	Maximum	
Unit	0	16	0
Address	The address in the WHM Cascade of the current unit.		
Min	1	16	1
Address	WHM Manager only: The minimum address in the WHM cascade		
Max	1	16	16
Address	WHM Manager only: The maximum address in the WHM cascade		
Cascade	9600, 19200, 38400, 57600		9600
Baud Rate	The rate at which information is transferred in a communication channel.		
Network	5	999	30 sec.
Timeout	The timeout value before a Modbus Fault is declared due to no response from the WHM Manager unit or (if a Manager) from the BAS		
Error	1	9	5
Threshold	The number of Modbus Comm errors allowed before invoking a Modbus Comm Fault.		
Comm Error	0 0 0 0 0 0 0		Read Only
1- 8	WHM Manager only: Displays the number of comm errors on Clients 1 – 8		
Comm Error	0 0 0 0 0 0 0		Read Only
9- 16	WHM Manager only: Displays the number of comm errors on Clients 9 – 16		
SSD Address	0	250	0
	The Client/Client Device address (for backwards compatibility).		
SSD Temp	Degrees or Points		Degrees
Format	WHM Manager only: Choose Degrees or Points		
Unit Failsafe	Constant Setpt or Shutdown		Constant Setpt
Mode	Specifies the plant's operating mode if there is a loss of communication with BAS		
Unit Failsafe	60	170	160
Setpoint	Specifies the plant's setpoint if there is a loss of communication.		
Time &	Enabled/Disabled		Enabled
Date Sync	WHM Manager only: If Enabled, all WHM Client units will synchronize time and date with the WHM Manager.		
WHM Min	1	16	1
Units	WHM Manager only – The minimum number of unit's valve open all the time in the WHM cascade (may differ from Min Address)		
WHM Max	1	16	1
Units	WHM Manager only: The maximum number of units in the WHM cascade (it can differ from Max Address)		
WHM On	15 Sec	300 Sec	60 Sec
Timeout	WHM Manager only – Specifies the time the WHM Manager must wait for a Client unit to turn on.		



WHM CLIENT SCREEN



WHM MANAGER SCREEN

Figure 8-5: Cascade Communication Screens

WHM Cascade → Application Configuration Parameters			
Menu Item Display	Available Choices or Limits		Default
	Minimum	Maximum	
Application	Read Only		DHW
	Specifies the application for the entire WHM Cascade.		
Operating Mode	Read Only		Constant Setpoint
	Specifies the operating mode for the entire WHM Cascade.		
WHM Setpoint	60°F	170°F	120°F
	Specifies the Setpoint for the entire WHM Cascade.		



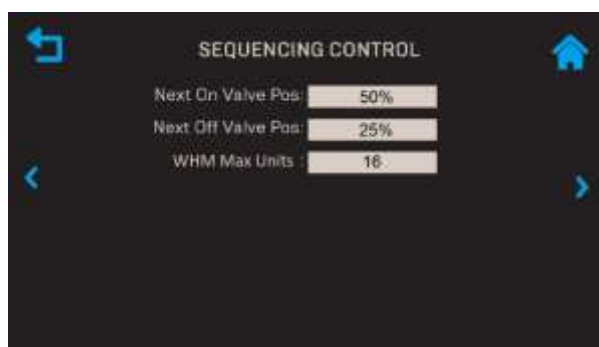
Figure 8-6: Application Configuration Screen

Remaining WHM parameters are in **WHM Cascade → Operating Controls**.

Operating Controls → Sequencing Control Parameters			
Menu Item Display	Available Choices or Limits		Default
	Minimum	Maximum	
Next On Valve Pos	16%	100%	50%
	The valve position that triggers the next unit to come on line.		
Next Off Valve Pos	16%	100%	25%
	The valve position that triggers the next unit to come off line.		
WHM Max Units	1	16	16
	WHM Manager only – The maximum number of units that will fire. For example: if there are 5 units, but this setting is set to 3, the plant will not fire more than 3 units.		



WHM Client Screen



WHM Manager Screen

Figure 8-7: Operating Controls: Sequencing Controls Screens

Operating Controls → Anti-Cycling Parameters			
Menu Item Display	Available Choices or Limits		Default
	Minimum	Maximum	
On Delay	30	300	30
	The minimum time a unit must stay off after shutting down or going into standby.		
WHM Off Delay	30	300	30 sec.
	The amount of time the low fire position will be delayed.		
Shutoff Delay Temp	0	25	5
	The temperature above setpoint the unit may rise to during delay shutdown.		



Figure 8-8: Operating Controls: Anti-Cycling Control Screen

Operating Controls → Valve Configuration Parameters			
Menu Item Display	Available Choices or Limits		Default
	Minimum	Maximum	
Select Output	Aout 2		Read Only
	Select the output you want to configure.		
Output Signal Type	Current		Read Only
	Select the output signal type of the selected output.		
Control Mode	On/Off		Read Only
	Select the Control Mode for the selected output (Standard Setup)		
Valve Feedback	Enabled/Disabled		Disabled
	Allows Valve Feedback functionality to be enabled; Valve Feedback Status appears.		
Valve Feedback Timer	30 Sec.	240 Sec.	60 Sec.
	The amount of time for the valve to open before returning an error.		
Valve Feedback Status	Open, Close		Read Only
	Displays the status of the selected valve.		

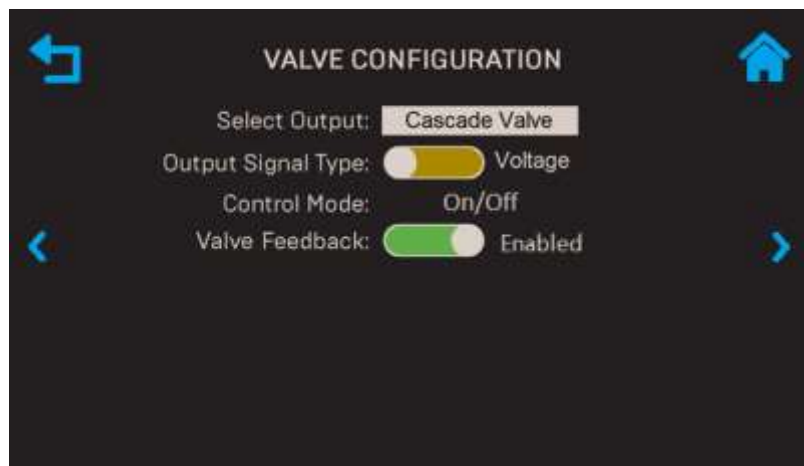


Figure 8-9: Operating Controls: Valve Configuration Screen

Operating Controls → Lead/Lag Control Parameters			
Menu Item Display	Available Choices or Limits		Default
	Minimum	Maximum	
Lead/Lag Setting	Run Hours, Unit Size, Select Lead/Lag		Run Hours
	Specify how the Lead and Lag units will be selected.		
Run Hours	25	225	72
	Specify the number of hours after which the Lead unit is rotated.		
Lead Unit	0	16	0
	Specify the address of the Lead unit.		
Lag Unit	0	16	16
	Specify the address of the Lag unit.		



Figure 8-10: Operating Controls: Lead/Lag Control Screen

8.7 WHM Hardware Installation & Set-Up Instructions

The following sections provide the basic installation and set-up instructions for implementing a Water Heater Management System (WHM) to control up to 16 Centurion Water Heaters.

8.7.1 Installation Notes

Multi-unit configurations require a sequencing valve. Building automation system is available on-board via Modbus TCP, BACnet MSTP and BACnet IP (go to **Main Menu** → **Advanced Setup** → **Comm & Network** → **BAS**).

If using ProtoNode SSD then you **must** adhere to the procedure below. Failure to complete these steps can result in the failure of the WHM system.

- Do **NOT** install the ProtoNode Device at the outset of the installation. If already installed, you must physically disconnect it from the Modbus network in I/O board.
- Make sure that the Modbus load and bias resistors are properly configured for the system to operate without the ProtoNode installed.
- Temporarily set the WHM system for Constant Setpoint mode of operation (see below).
- Turn on and completely test the installation to verify that it is operating proper.
- Once the installation is working properly as a WHM system, install the ProtoNode Device.
- Make sure that the Modbus load and bias resistors are properly configured for the system to operate with the ProtoNode installed.
- Set the WHM system for desired mode of operation (Setpoint mode).
- Test the system completely with the ProtoNode installed.

8.7.2 Hardware Installation

All Centurion Water Heaters that will be controlled by a WHM Manager must be equipped with an actuator-controlled Sequencing Isolation Valve. If this valve is not already installed at the outlet, complete the instructions in Section 2.13.

8.7.3 WHM Modbus Network Wiring

As previously mentioned, all units being controlled by the WHM will be connected to a RS485 Modbus Network. All Modbus networks are wired in a daisy-chain configuration using a Manager/Client scenario as shown below.

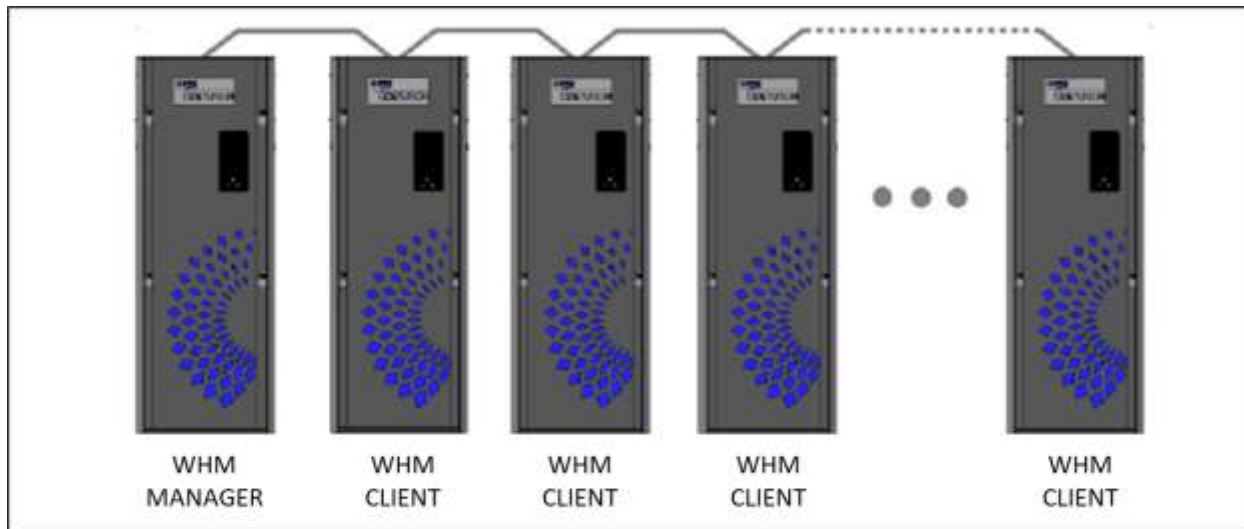


Figure 8-11: Typical Daisy-Chain Modbus/RS485 Network

NOTE: WHM Manager doesn't necessarily have to be on either end of the Daisy-Chain loop.

Any one of the Edge WHM units included in the Modbus network can be the Manager. However, it is recommended that you decide which unit will be the Manager and which will be the last unit on the daisy-chain prior to performing the wiring connections. This will simplify wiring connections and Modbus address assignments.

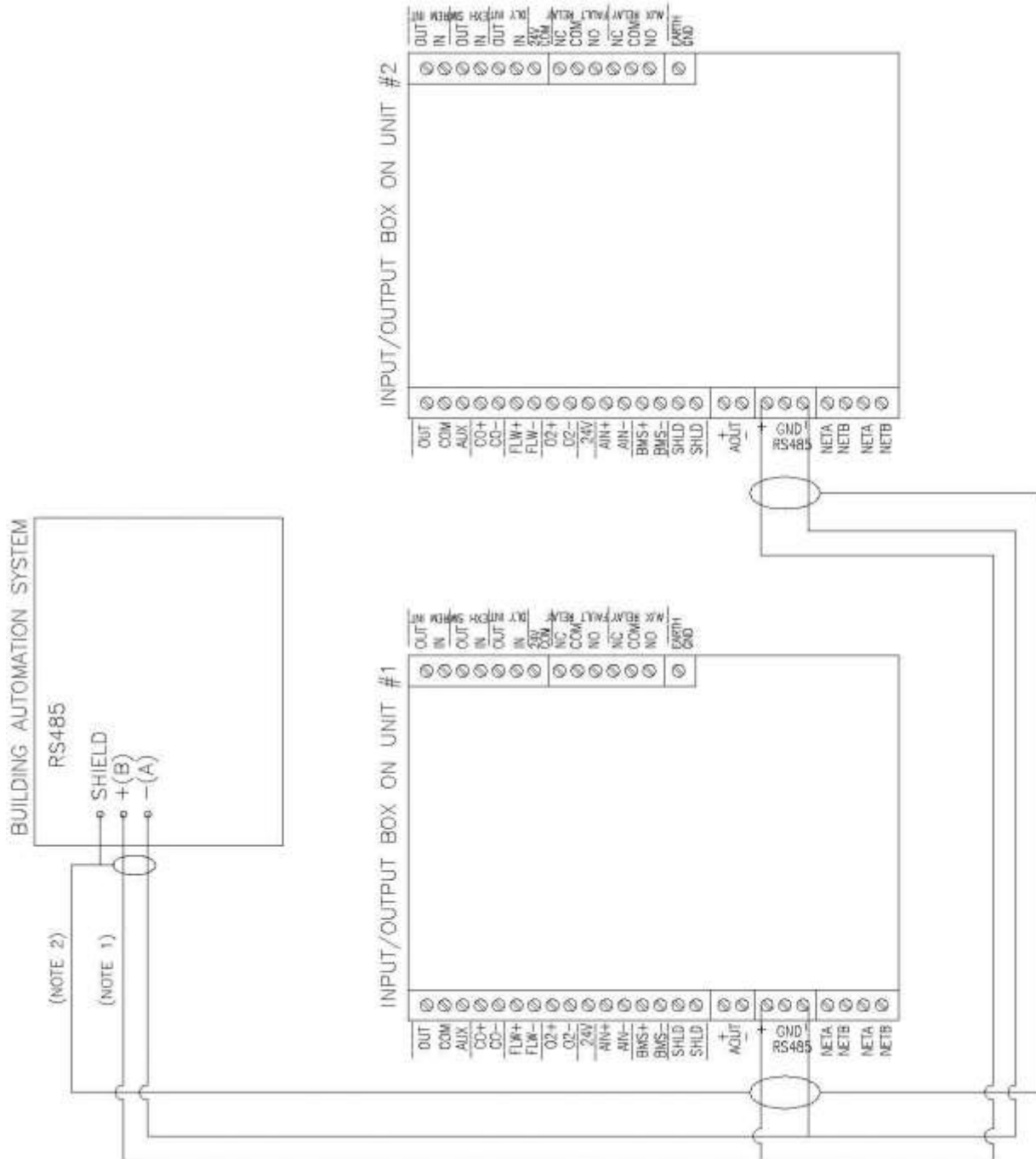
Modbus network wiring connections must be made using shielded twisted-pair wiring, (18 – 24 AWG) such as Belden #9841, #3105A, #8760, or equivalent. The Modbus wiring connections are made at the BST/WHM RS485+, BST/WHM RS485- and RS485 ISO GND terminals on the I/O board included with each Edge Controller.

To Connect Modbus wiring:

1. Starting at the first unit, connect the twisted, shielded pair cable to the BST/WHM RS485 plus (+) and minus (-) terminals on the left side I/O board, RS485 ISO GND (**Error! Reference source not found.**).
2. At the I/O board of the first unit in the daisy chain (not necessarily Manager), activate the DIP switch labeled "MODBUS TERM" by placing it in the up position. This will connect a termination resistor across the terminals at the source end.
3. Refer to Figure 8.7-3 and run the shielded cable to the next unit in the daisy-chain and connect the + and - wire leads (+ to +, - to -). DO NOT connect the shield of the RS485 Comm leads to the SHIELD terminal at the Client. Instead, connect the shields of the incoming and outgoing RS485 leads together. Shield must be connected only at one location in the daisy chain.
4. Continue connecting the + and - wire leads and shields for the remaining units as described in step 3 for the remaining Client units in the chain.
5. At the end unit in the chain, activate the DIP switch labeled "MODBUS TERM" by placing it in the up position. This will ensure the termination resistors are activated at both ends.

8.7.4 Control And Power Wiring

Control and power wiring connections to the Sequencing Valves associated with each Edge WHM unit is accomplished by ensuring that the 5-pin Molex connectors on the units are connected to the corresponding connectors on the valves.

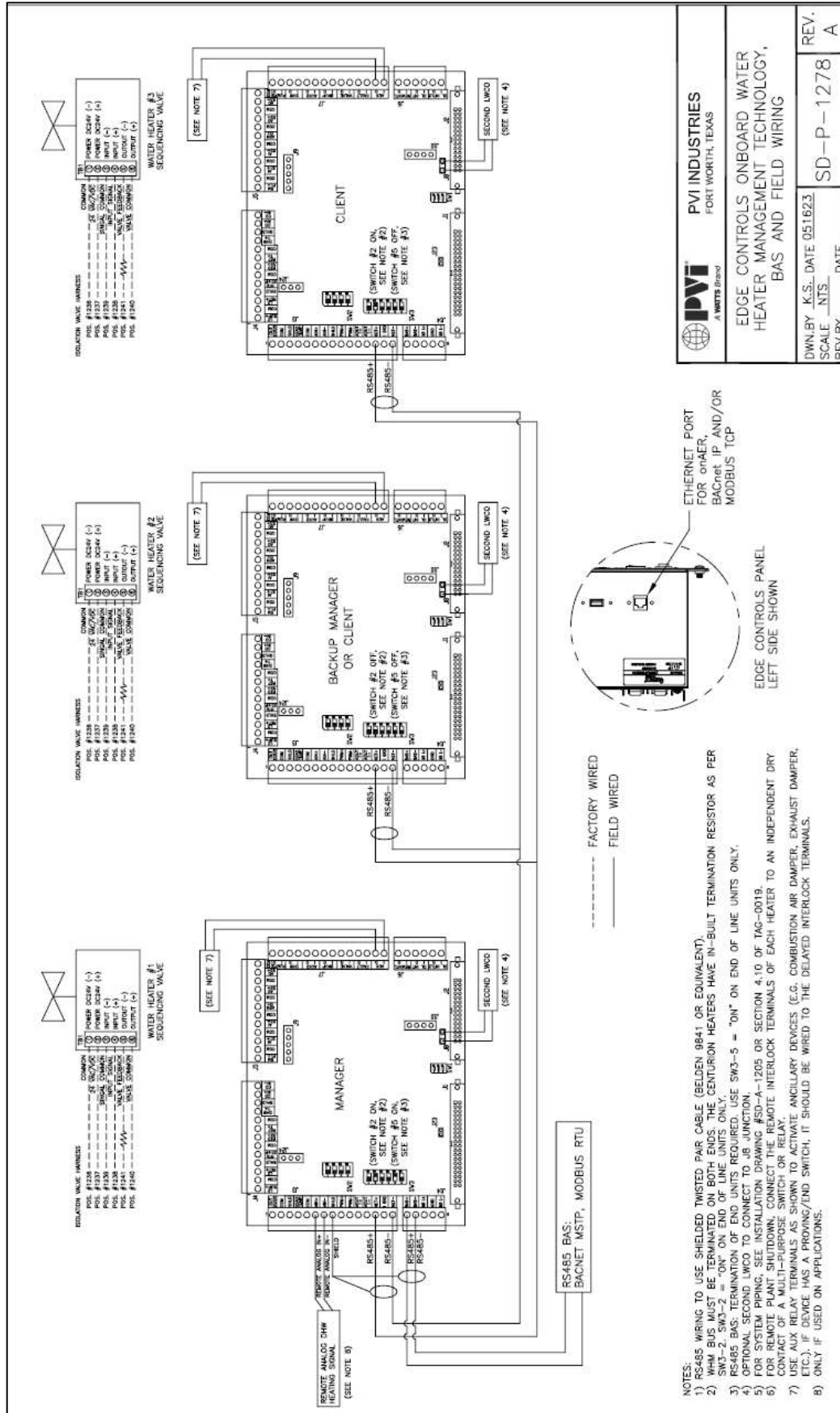


NOTES:

- 1) WIRING TO BE SHIELDED TWISTED PAIR CABLE (BELDEN 9841 OR EQUIVALENT).
- 2) TERMINATE SHIELDS AT THE SOURCE ONLY, DO NOT CONNECT AT THE UNITS.
- 3) ON THE CPU BOARD INSIDE THE CONTROL PANEL OF THE LAST UNIT ONLY, TURN THE DIPSWITCHES LABELED BIAS1. TERM, AND BIAS2 TO THE "ON" POSITION.
- 4) THIS DRAWING APPLIES ONLY IF WATER HEATER MANAGEMENT IS NOT BEING USED.

Reference SD-A-659

Figure 8-12: WHM Network Wiring Diagram



- NOTES:
- 1) RS485 WIRING TO USE SHIELDED TWISTED PAIR CABLE (BELDEN 9841 OR EQUIVALENT).
 - 2) WHM BUS MUST BE TERMINATED ON BOTH ENDS. THE CENTURION HEATERS HAVE IN-BUILT TERMINATION RESISTOR AS PER SW3-2. SW3-2 = "ON" ON END OF LINE UNITS ONLY.
 - 3) RS485 BAS: TERMINATION OF END UNITS REQUIRED. USE SW3-5 = "ON" ON END OF LINE UNITS ONLY.
 - 4) OPTIONAL SECOND LWCO TO CONNECT TO JB JUNCTION.
 - 5) FOR SYSTEM PIPING, SEE INSTALLATION DRAWING #SD-A-1205 OR SECTION 4.10 OF TAG-0019.
 - 6) FOR REMOTE PLANT SHUTDOWN, CONNECT THE REMOTE INTERLOCK TERMINALS OF EACH HEATER TO AN INDEPENDENT DRY CONTACT OF A MULTI-PURPOSE SWITCH OR RELAY.
 - 7) USE AUX RELAY TERMINALS AS SHOWN TO ACTIVATE ANCILLARY DEVICES (E.G. COMBUSTION AIR DAMPER, EXHAUST DAMPER, ETC.). IF DEVICE HAS A PROXING/END SWITCH, IT SHOULD BE WIRED TO THE DELAYED INTERLOCK TERMINALS.
 - 8) ONLY IF USED ON APPLICATIONS.

Reference
SD-P-1278

Figure 8-13: WHM Network Wiring Diagram

8.8 WHM Programming & Start-Up

All required hardware installation and network wiring must be completed *before* configuring the WHM parameters into the WHM Manager and Client units. In addition, the required menu entries must be determined based on the descriptions in the previous sections.

PVI recommends that the WHM Manager be set up first. By doing so, the Manager will “push” most of the operating parameters to each WHM Client when they are brought on-line. For clarity, the instructions below assume that the WHM Manager and Clients will be consecutively numbered, starting at 1 (WHM Manager, although that’s not required).

8.8.1 WHM Manager Configuration

Complete the WHM Manager Programming & Start-Up instructions below on the single unit designated as the WHM Manager.

1. Go to: **Main Menu → Advanced Setup → WHM Cascade → Cascade Configuration.**
 - a. Set the WHM Unit Mode to WHM Manager.
 - b. You have the option of designating one of the units in the WHM Cascade as a Backup Manager. If the WHM Manager fails, manager functionality will automatically transfer to the designated Backup Manager. To use this functionality, enable the **Auto-Manager Transfer** parameter, then specify the Backup Manager’s address in the **Backup Manager Addr** parameter. You can also enter a delay before transferring manager functionality in the **Auto-Manager Timer** parameter.
2. Go to: **Advanced Setup → WHM Cascade → Application Configuration.**
3. Set the **WHM Setpoint** parameter to the desired setpoint temperature.
4. Go to **Advanced Setup → WHM Cascade → Cascade Comm** and configure the following:

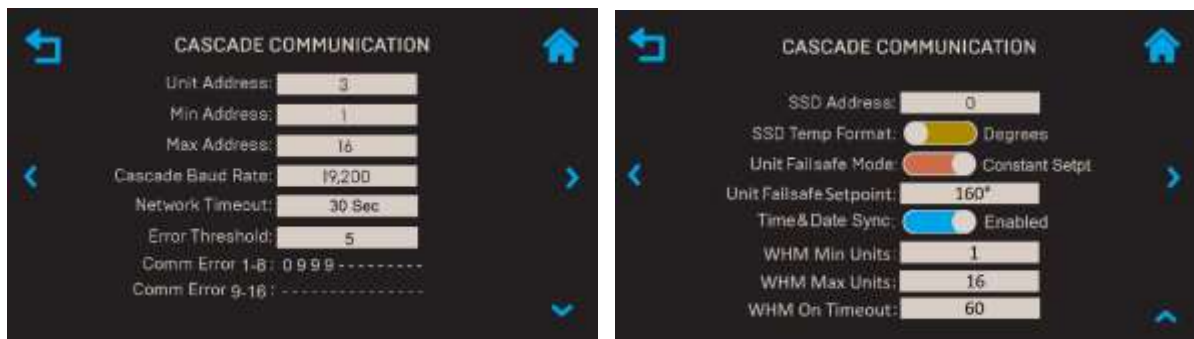


Figure 8-14: WHM Manager Cascade Communication Screens

- a. Specify the WHM Manager’s address in the **Unit Address** parameter.
- b. Specify the Cascade’s minimum and maximum address in the **Min Address** and **Max Address** parameters (typically 1-max number of units in the cascade).
- c. Set the communication parameters in the **Cascade Baud Rate**, **Network Timeout** and **Error Threshold** parameters.
- d. Specify the **Plant Failsafe Mode**, which determines what the entire plant does if the WHM Manager loses communication with the WHM Client units.
- e. Check that the **Manager** LED is lit on the Controller’s front face.

5. Go to: **Advanced Setup → WHM Cascade → Operating Controls → Sequencing Control**. The **Next On Valve Pos** parameter specifies the valve position that will trigger the next unit to come on line, and the **Next Off Valve Pos** parameter specifies the valve position that will trigger the next unit go off-line.
6. The Controller includes a *Setback* option, which can be used to adjust the setpoint temperature, start and end time, for operation during periods of low demand. To specify the setback time and temperature, go to: **Main Menu → Advanced Setup → Performance → Temperature Control → Setpoint Range** and configure the following parameters:
 - a. Set the **Setpoint Limiting** parameter to **Enabled**.
 - b. Configure **Setpoint Low Limit** and **Setpoint High Limit** parameters to determine the temperature range within which the setpoint can vary. You can also configure the **Setpoint Limit** parameter, which allows you to set the number of degrees *below Setpoint High Limit* the unit's outlet temperature must fall before restart. Enable **Setpoint Limiting** and then configure the **Setpoint Limit Band**.
7. If you want to change the Lead/Lag Hours, go to **Advanced Setup → WHM Cascade → Operating Controls → Lead/Lag**, set **Lead/Lag Settings** to **Select Lead/Lag**, then select the Lead and Lag units in the **Lead Unit** and **Lag Unit** fields.

8.8.2 WHM Client Configuration & Start-Up Procedure

Complete the instructions below on all units designated as WHM Clients.

1. Go to: **Advanced Setup → WHM Cascade → Cascade Configuration** and set the **WHM Unit Mode** to **WHM Client**.
2. Go to: **Advanced Setup → WHM Cascade → Cascade Comm**.
3. Enter the Client unit's address in the **Unit Address** parameter,
4. Set the communication parameters in the **Cascade Baud Rate**, **Network Timeout** and **Error Threshold** parameters.
5. Specify the **Unit Failsafe Mode**, which determines what happens if a WHM Client units loses communication with the WHM Manager.
6. If you want to change the Lead/Lag Hours, go to: **Advanced Setup → WHM Cascade → Operating Controls → Lead/Lag**, set **Lead/Lag Settings** to **Select Lead/Lag**, then select the Lead and Lag units in the **Lead Unit** and **Lag Unit** fields.

8.9 Troubleshooting

TABLE 8.9: WHM Troubleshooting		
FAULT INDICATION	PROBABLE CAUSE	CORRECTIVE ACTION
Manager LEDs are flashing on 2 Controllers	1. Two Edge Controllers have their WHM Mode menu option set to WHM Manager.	1. Check the WHM Mode entries in the units which have their displays flashing. Change one of the WHM Mode settings to WHM Client.
MANAGER LED on one or more WHM units is Off .	1. Improperly connected or faulty RS485 Modbus wiring. 2. Improper Comm address. 3. Unit Comm address is not unique.	1. Check the polarity of the RS485 Comm connections on the I/O board of the affected unit. Also, ensure that all Modbus wiring connections to the unit are secure. 2. Verify that the address of the affected unit is within the allowable range (1 thru 16). 3. Check to ensure that none of the units have the same Comm address.
Actuator-controlled Sequencing Valve does not open	1. Control cable not connected to valve actuator. 2. 24 VDC power not being supplied to valve actuator. 3. Defective valve actuator.	1. Ensure that the control cable from the unit's I/O Box is connected to the valve actuator. 2. Remove the enclosure cover from the valve actuator and verify that 24 VDC is present at Terminal 2 of the actuator. 3. Replace valve actuator. Following replacement, the actuator stroke will have to be calibrated to ensure it fully opening and closing.

8.10 Sequencing Valve Description & Operation

Installation of the Sequencing Isolation Valve (P/N 21008C) is described in Section 2.13.

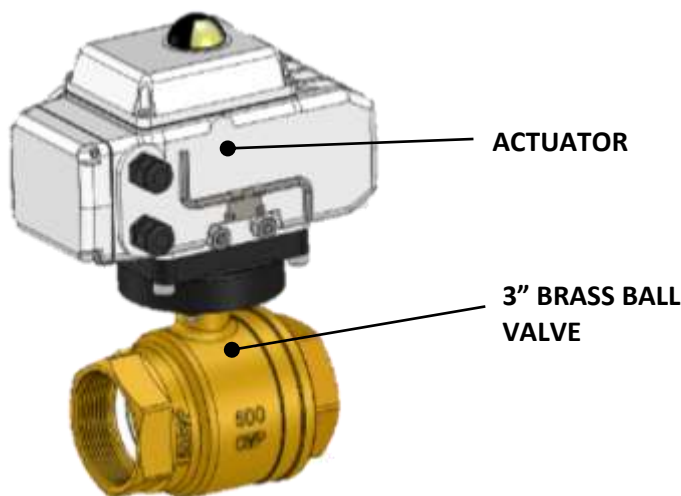


Figure 8-15: Actuator-Controlled Sequencing Valve (P/N 21008C)

The Actuator Housing contains a cover which is removed by simply loosening a single captive screw. Removing the cover provides access to a PC Board containing wiring connections and control circuitry components as shown.

The components on the PC board include DIP switches which are preset at the factory and should not be changed unless instructed to do so.

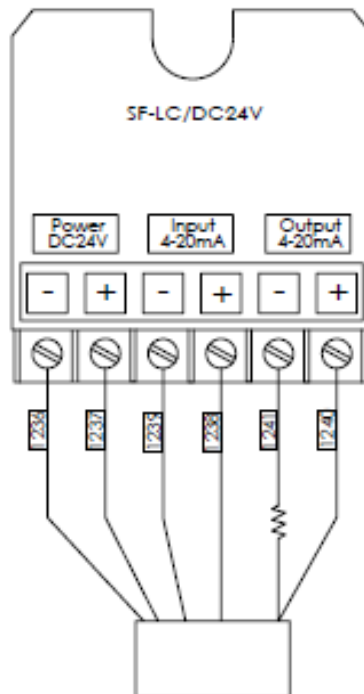


Figure 8-16: Actuator PC Board Components

NOTE: DO NOT press Auto-Stroke (Reset) button. Doing so may alter actuator calibration. Depress and hold brass clutch button to manually rotate valve.

CAUTION!

Power must be removed from the Actuator prior to attempting to manual override. Failure to observe this precaution may damage the Actuator.

A manual override is provided for use in setup or power failure situations. The override is operated with a standard hex wrench (included). To manually open or close the valve, disconnect the 5-pin connector on the Actuator to ensure 24 VDC power is not supplied.

8.10.1 Sequencing Valve Operating Characteristics

The Sequencing Valve is powered by 24 VDC power supply. The unit has a 5-pin molex valve harness and the valve has a mating 5-pin plug and play connector. The 5 pins are:

1. +24VDC
2. -24VDC
3. 4-20mA (Control Signal)
4. Common
5. 0-10V (Feedback)

During normal Water Heater Management (WHM), a control signal of less than (<) – 4mA will rotate the valve to the fully open (90°) position. Conversely, a control signal of 20 mA will rotate the valve to the fully closed (0°) position. The Sequencing Valve will send a status of the Valve (open/close) as a feedback signal (0–10 VDC) to the Edge Controller.

SECTION 9: O₂ TRIM OPERATION

Advanced combustion control systems need to maintain precise air/fuel ratios to maximize efficiency. Gas Water Heaters often deviate from the ideal air-fuel ratio due to environmental variations such as humidity, atmospheric pressure, filter dust loading, delivered gas energy content and other factors. If the Water Heater is operating with fixed blower/damper positions, the air/fuel ratio will normally vary within an acceptable level but will not be fully optimized for efficiency and reliability.

The O₂ Trim system is designed to measure and maintain an ideal air-fuel ratio in Centurion Water Heaters, thus maximizing efficiency and reliability while minimizing emissions.

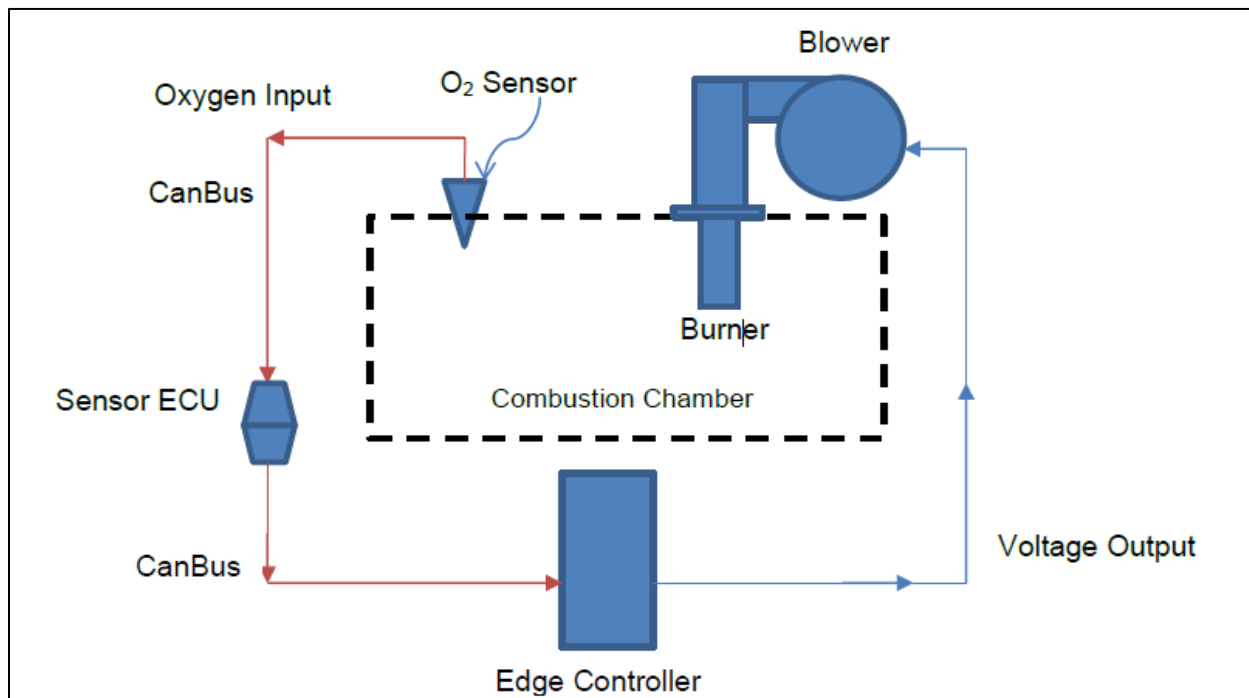


Figure 9-1: Simplified O₂ Trim Diagram

WARNING:

O₂ Trim and combustion calibration can both alter the voltage sent to the blower and can thus interfere with each other. If a change is made to any calibration point during combustion calibration, you must make a corresponding change to the same calibration point in O₂ Trim. If you fail to make the change in O₂ Trim, it may ignore the combustion calibration value and adjust the O₂ to the O₂ Trim value instead.

NOTE: For full instructions and menu options, see OMM-0161 Section 6.6.1.

9.1 Operation Details

During operation, the O₂ Trim system will adjust the command voltage sent to the combustion air blower within a limited range. The amount of voltage trim depends on the error between the desired O₂% (target %) and the current reading of the O₂ sensor (O₂%) and also on high and low limits of blower voltage for each valve position. The total amount of corrective voltage trim is limited by the controller to insure safe and reliable operation of the system.

Figure 9-2 graphically shows the functional logic of the O₂ Trim system and how the blower voltage (BV), O₂ Limits, and air/fuel ratio interact during an O₂ Trim operation. The limits are fixed presets within the controller. The target range is adjustable within these limits to allow the user to select the optimal air/fuel ratio for a particular Water Heater or application.

Figure 9-2 shows how the controller would react to an O₂% reading above the upper limit. It will reduce the blower voltage (BV) until the O₂% reading is within the Target Range, provided the BV adjustments are within the limits for that fire rate. The control will then store this as the new BV calibration setting until changed manually or by another O₂ Trim function cycle.

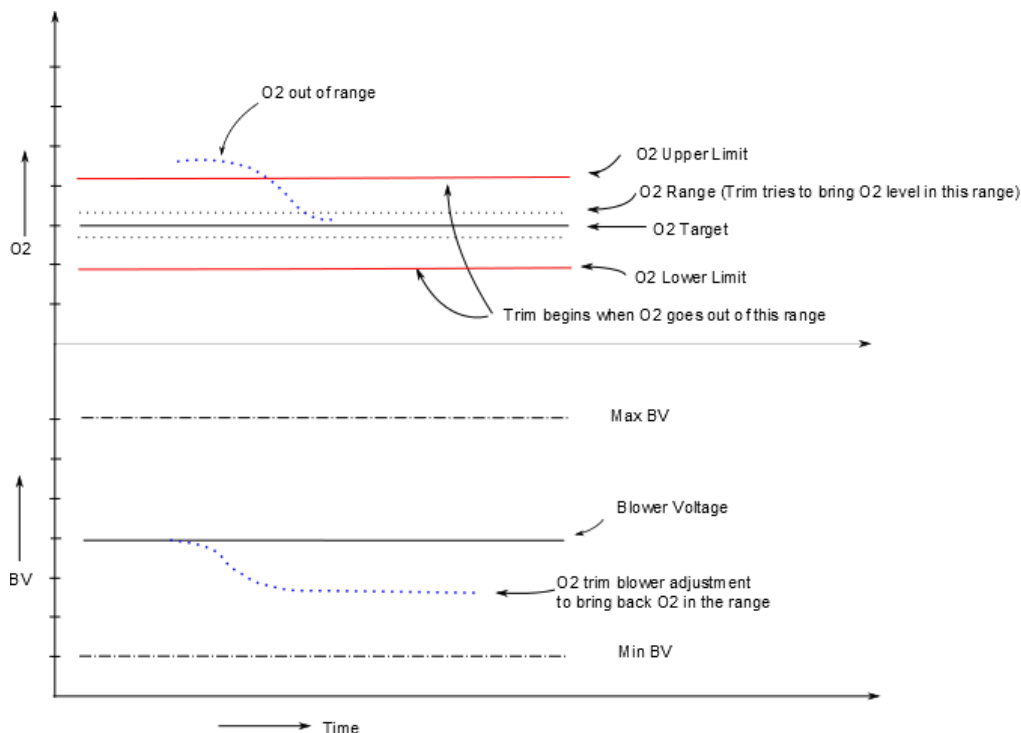


Figure 9-2: O₂ Trim Logic

Once the system operational stability conditions are met, the O₂ Trim system will:

1. Lock the fire rate at the current position that needs adjustment to the air/fuel ratio.
2. The **Demand** LED will flash once per second to indicate that the trim function has started.
3. Check the oxygen levels inside the combustion chamber:
 - If oxygen levels are within the set range, O₂ Trim releases control.
 - If oxygen levels are outside the set range, O₂ Trim will adjust Blower Voltage to bring the Water Heater back to the Target O₂ value.

This process repeats until the target oxygen range is achieved or the unit reaches the allowable blower voltage limit.

9.2 O₂ Sensor Calibration

O₂ sensor calibration can be initiated by pressing the Calibrate button on the Edge's **O₂ Sensor** screen (**Main Menu → Calibration → Input/Output → O₂ Sensor**). Connect the combustion analyzer to the exhaust to perform the O₂ sensor calibration. Once the calibration starts, the Edge ignites the unit and waits 2 minutes for the sensor to settle. Enter the O₂ reading from the analyzer to complete the calibration process.

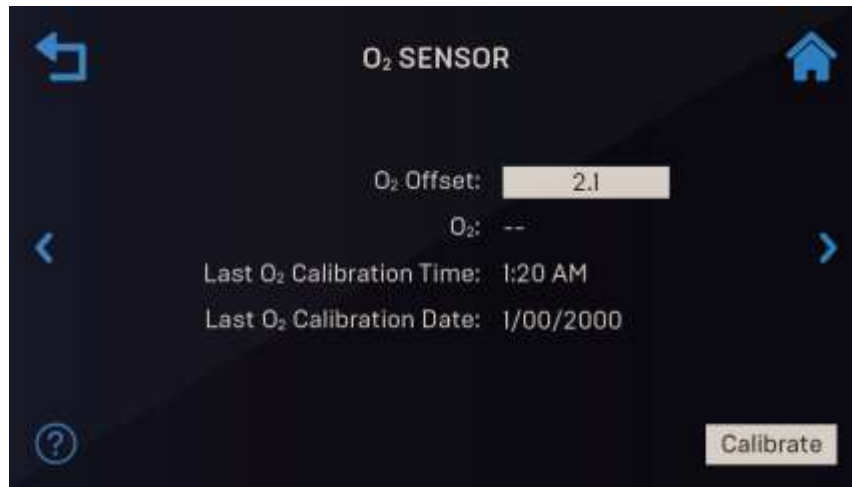


Figure 9-3: O₂ Sensor Calibration Screen

9.3 Trim Menu Values and Defaults

There are three O₂ Trim screens, available from **Main Menu → Advanced Setup → Performance → O₂ Trim**.

- **O₂ Trim Settings:** To enable O₂ Trim, set the **O₂ Trim** parameter to **Enabled**. You can then adjust the **O₂ Offset**, **Settle Time**, **O₂ Trim Gain** and **O₂ Trim Iteration Limit** parameters to values appropriate for the unit, per the table below.



Figure 9-4: O₂ Trim Settings Screen

- **O₂ Trim Parameters:** Choose a **Valve Position** and then set the **O₂ Target**, **Upper** and **Lower Limits** for the valve position. You can then repeat this for all other valve positions, per the tables below.

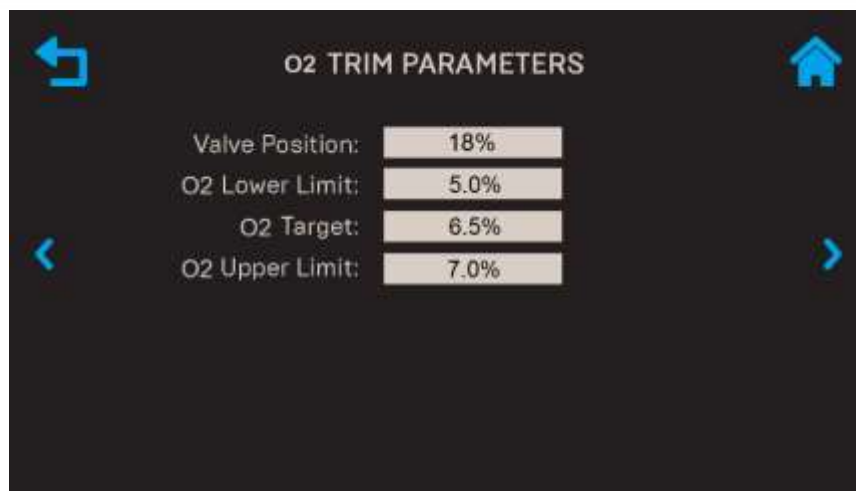


Figure 9-5: O₂ Trim Parameters Screen

- **O₂ Trim Status:** Displays the current status of O₂ Trim operation.

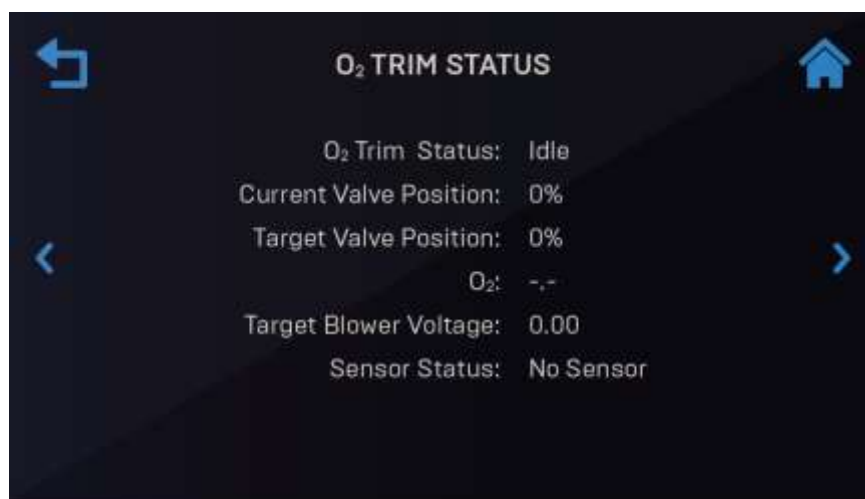


Figure 9-6: O₂ Trim Status Screen

For more information, see the *Edge Controller Manual* (OMM-0161, GF-213), Section 6.6.1.

CEN 2000/ O₂ Trim Values				
MENU ITEM		Minimum	Maximum	Default
Settle Time		0	120 Sec	20 Sec
O ₂ Trim Gain		0.1	5.0	0.250
Max Tries		0	100	15
O ₂ Target (must be between O ₂ Upper & O ₂ Lower)	18%	3%	8%	5.6%
	30%	3%	8%	5.6%
	40%	3%	8%	5.8%
	50%	3%	8%	5.6%
	60%	3%	8%	5.6%
	70%	3%	8%	5.6%
	80%	3%	8%	5.6%
O ₂ Lower (must be at least 1% lower than O ₂ Upper)	100%	3%	8%	5.6%
	18%	2.5%	5.5%	5.1%
	30%	2.5%	5.5%	5.1%
	40%	2.5%	5.5%	5.4%
	50%	2.5%	5.5%	5.1%
	60%			5.1%
	70%	2.5%	5.5%	5.1%
O ₂ Upper (must be at least 1% higher than O ₂ Lower)	80%			5.1%
	100%	2.5%	5.5%	5.1%
	18%	5.5%	8.5%	6.1%
	30%	5.5%	8.5%	6.1%
	40%	5.5%	8.5%	6.2%
	50%	5.5%	8.5%	6.1%
	60%			6.1%
O ₂ Offset	70%	5.5%	8.5%	6.1%
	80%			6.1%
	100%	5.5%	8.5%	6.1%

CEN 1600 O₂ Trim Values				
MENU ITEM		Minimum	Maximum	Default
Settle Time		0	120 Sec	20 Sec
O ₂ Trim Gain		0.1	5.0	0.250
Max Tries		0	100	15
O ₂ Target (must be between O ₂ Upper & O ₂ Lower)	18%	3%	8%	5.6%
	30%	3%	8%	5.6%
	40%	3%	8%	5.8%
	50%	3%	8%	5.6%
	60%	3%	8%	5.6%
	70%	3%	8%	5.6%
	80%	3%	8%	5.6%
O ₂ Lower	100%	3%	8%	5.6%
	18%	2.5%	5.5%	5.1%
	30%	2.5%	5.5%	5.1%
	40%	2.5%	5.5%	5.1%

(must be at least 1% lower than O ₂ Upper)	50%	2.5%	5.5%	5.1%
	60%			5.1%
	70%	2.5%	5.5%	5.1%
	80%			5.1%
	100%	2.5%	5.5%	5.1%
O ₂ Upper (must be at least 1% higher than O ₂ Lower)	18%	5.5%	8.5%	6.1%
	30%	5.5%	8.5%	6.1%
	40%	5.5%	8.5%	6.1%
	50%	5.5%	8.5%	6.1%
	60%			6.1%
	70%	5.5%	8.5%	6.1%
	80%			6.1%
	100%	5.5%	8.5%	6.1%
O ₂ Offset		-3.0	3.0	1.0

CEN 2000 O₂ Trim Values (Propane)				
MENU ITEM		Minimum (%)	Maximum (%)	Default (%)
Settle Time		0	120 Sec	20 Sec
O ₂ Trim Gain		0.1	5.0	0.250
Max Tries		0	100	15
O ₂ Target (must be between O ₂ Upper & O ₂ Lower)	18%	3.5	7.0	5.5
	30%	3.5	7.0	5.5
	40%	3.5	7.0	5.5
	50%	3.5	7.0	5.5
	60%	3.5	7.0	5.5
	70%	3.5	7.0	5.5
	80%	3.5	6.5	5.5
	100%	3.5	6.5	5.5
O ₂ Lower (must be at least 1% lower than O ₂ Upper)	18%	3.0	5.5	4.5
	30%	3.0	5.5	4.5
	40%	3.0	5.5	4.5
	50%	3.0	5.5	4.5
	60%	3.0	5.5	4.5
	70%	3.0	5.5	4.5
	80%	3.0	5.5	4.5
	100%	3.0	5.5	4.5
O ₂ Upper (must be at least 1% higher than O ₂ Lower)	18%	5.5	8.0	6.5
	30%	5.5	8.0	6.5
	40%	5.5	8.0	6.5
	50%	5.5	8.0	6.5
	60%	5.5	8.0	6.5
	70%	5.5	8.0	6.5
	80%	5.5	7.0	6.0
	100%	5.5	7.0	6.0
O ₂ Offset		-3.0	3.0	1.0

CEN 1600 O₂ Trim Values (Propane)				
MENU ITEM		Minimum	Maximum	Default
Settle Time		0	120 Sec	20 Sec
O ₂ Trim Gain		0.1	5.0	0.250
Max Tries		0	100	15
O ₂ Target (must be between O ₂ Upper & O ₂ Lower)	18%	4.5	6.5	5.5%
	30%	4.5	6.5	5.5%
	40%	4.5	6.5	5.5%
	50%	4.5	6.5	5.5%
	60%	4.5	6.5	5.5%
	70%	4.5	6.5	5.5%
	80%	4.5	6.5	5.5%
O ₂ Lower (must be at least 1% lower than O ₂ Upper)	18%	3.0	5.5	4.5
	30%	3.0	5.5	4.5
	40%	3.0	5.5	4.5
	50%	3.0	5.5	4.5
	60%	3.0	5.5	4.5
	70%	3.0	5.5	4.5
	80%	3.0	5.5	5.0
O ₂ Upper (must be at least 1% higher than O ₂ Lower)	18%	5.5	8.0	6.5
	30%	5.5	8.0	6.5
	40%	5.5	8.0	6.5
	50%	5.5	8.0	6.5
	60%	5.5	8.0	6.5
	70%	5.5	8.0	6.5
	80%	5.5	7.5	6.0
O ₂ Offset		-3.0	3.0	1.0

CEN 2000/ O₂ Trim Adjustment Range			
CALIBRATION POINT	BLOWER VOLTAGE (Volts)		
	Minimum	Maximum	Default
18%	2.20	3.20	2.50
30%	3.20	4.30	3.50
40%	3.60	4.90	4.10
50%	3.70	5.30	4.25
60%	3.90	5.60	4.60
70%	4.40	6.30	5.00
80%	5.00	6.70	5.70
100%	6.20	8.10	7.20

CEN 1600 O₂ Trim Adjustment Range (Natural Gas)			
CALIBRATION POINT	BLOWER VOLTAGE (Volts)		
	Minimum	Maximum	Default
18%	2.20	3.20	2.50
30%	3.20	4.30	3.60
40%	3.60	4.90	4.10
50%	3.70	5.30	4.50
60%	4.10	5.60	4.85
70%	4.20	5.80	5.15
80%	4.80	6.20	5.50
100%	5.40	7.00	6.25

CEN 2000 O₂ Trim Adjustment Range (Propane Gas)			
CALIBRATION POINT	BLOWER VOLTAGE (Volts)		
	Minimum	Maximum	Default
18%	2.15	2.90	2.36
30%	2.95	4.15	3.20
40%	3.45	4.90	3.90
50%	3.65	5.20	4.12
60%	3.85	5.55	4.53
70%	4.35	6.30	5.06
80%	4.85	6.55	5.60
100%	5.70	8.40	7.12

CEN 1600 O₂ Trim Adjustment Range (Propane Gas)			
CALIBRATION POINT	BLOWER VOLTAGE (Volts)		
	Minimum	Maximum	Default
18%	2.15	2.90	2.46
30%	2.95	4.15	3.48
40%	3.45	4.90	3.95
50%	3.65	5.20	4.21
60%	4.00	5.60	4.52
70%	4.20	5.85	4.75
80%	4.45	6.00	5.08
100%	4.90	7.00	5.75

9.4 Trim Maintenance and Troubleshooting

The O₂ Trim system depends on the O₂ sensor. It is recommended that you **inspect the oxygen sensor for accuracy every 12 months** by comparing it to a sensor reading from a properly calibrated flue analyzer. This is because contaminated air or gas supplies may cause buildup and shift the calibration point. An offset value of $\pm 3.0\%$ can be entered in the **O₂ Offset** parameter in the **O₂ Trim Settings** screen (see Figure 9-4) to correct the reading during manual calibration. If the sensor has a large amount of offset, a replacement may be required.

Occasional software updates to the device may be required.

O ₂ Trim General Warnings		
Warning	Cause	Possible Solutions
O ₂ Percentage Low	O ₂ Levels less than 2% for more than 30 seconds (auto-reset when valve comes back in range)	Dirty filter or poor combustion calibration – recalibrate unit
		O ₂ Offset too low – Increase Offset value
		Bad Sensor-Replace
O ₂ Sensor Malfunction	O ₂ Levels less than -4% or more than 24% for more than 10 seconds {manual clearing of this fault is required}	Bad Sensor-Replace Communication Issue – check wires and connections
Warning O ₂ Level High	O ₂ Levels > 9% and < 24% for more than 30 seconds {auto-reset when value comes back in range}	Gas Pressure Regulator or Air Blower Problem, or bad Combustion Calibration
		O ₂ Offset too high
		Bad Sensor-Replace
O ₂ Sensor Out of Range	Sensor auto calibration offset required is more than $\pm 3\%$	Reset Unit-Recalibrate Sensor
		Bad Sensor-Replace
		Bad ECU-Replace (Rare)
O ₂ Warning Service Required	If the O ₂ level is outside of its limits for more than 5 minutes. For example: 1) Reading < Lower Limit & Blower Voltage = BV Limit -OR- 2) Reading > Upper Limit & Blower Voltage = BV Limit	Gas Supply, Air Filter, or Air Blower issue
		Bad Sensor-Replace

The Edge Controller displays following statuses in the **O₂ Trim Status** parameter on the **Advanced Setup → Performance → O₂ Trim → O₂ Trim Status** screen.

O₂ Trim Operation Interruption Errors		
Status Messages	Description	Action
Idle	O ₂ Trim is not active	None-Normal Operation
O ₂ Wait	O ₂ Trim is waiting for to initiate the process	None-Normal Operation
Hunt	O ₂ Trim is looking for target	None-Normal Operation
WaitLock	O ₂ Trim found the target, waiting for system to stabilize	None-Normal Operation
Locked	O ₂ Trim is ready to start the process	None-Normal Operation
Adjust	O ₂ trim is correcting the system	None-Normal Operation
Settle	System is settling after the correction	None-Normal Operation
Done	O ₂ Trim is successfully completed	None-Normal Operation
BV Hi Err	O ₂ Trim operation exceeds blower voltage limits	Check air filter, gas regulator, combustion calibration
BV Lo Err		Check sensor calibration; it may need to be replaced
Max Iter	O ₂ Trim Operation reached maximum iteration. Wait and try again	Check sensor calibration for inaccuracies
		Increase gain or iteration attempts
Outlet Out of Rng	Outlet temp is outside of temperature range	None-Normal Operation
FR Out of Rng	Fire Rate is not within track range during trim operation	None – Steady State has not been achieved
O ₂ Trim in SP limit	Unit is in setpoint limiting	None – System is near the high temp limit.

SECTION 10: TROUBLESHOOTING

10.1 Introduction

This section is intended to aid service/maintenance personnel in isolating the cause of a fault in your Centurion Water Heater. The troubleshooting procedures below are presented in tabular form on the following pages. These tables are comprised of three columns labeled: Fault Indication, Probable Cause and Corrective Action. The numbered items in the Probable Cause and Corrective Action columns correspond to each other. For example, Probable Cause No. 1 corresponds to Corrective Action No. 1, etc.

NOTE: All O₂ Trim troubleshooting messages are included in Section 9.4, above.

When a fault occurs in the unit, proceed as follows to isolate and correct the fault:

10.1.1 Fault Correction

1. Observe the fault messages displayed on the Edge Controller.
2. Refer to the Fault Indication column in the table below, and locate the Fault that best describes the existing conditions.
3. Proceed to the Probable Cause column and start with the first item for the Fault Indication.
4. Perform checks and procedures listed in the Corrective Action column for the first Probable Cause candidate.
5. Continue checking each additional Probable Cause for the existing fault until the fault is corrected.
6. Section 10.2 contains additional troubleshooting information that may apply to situations in which no fault message is displayed.

If the fault cannot be corrected using the information provided in the Troubleshooting Tables, contact your local PVI Representative.

Centurion Troubleshooting Procedures		
Fault	Probable Causes	Corrective Action
AIRFLOW FAULT DURING IGNITION	1. Blower stopped running due to thermal or current overload.	1. Check combustion blower for signs of excessive heat or high current drain that may trip thermal or current overload devices.
	2. Blocked Blower inlet or inlet air filter.	2. Inspect the inlet to the combustion blower including the air filter at the air/fuel valve for signs of blockage.
	3. Blockage in Blower Proof switch.	3. Remove the Blower Proof switch and inspect for signs of blockage, clean or replace as necessary.
	4. Blockage in Blocked Inlet switch.	4. Remove the Blocked Inlet switch and inspect for signs of blockage, clean or replace as necessary.
	5. Defective Blower Proof switch.	5. Check the continuity of the Blower Proof switch with the combustion blower running. If there is an erratic resistance reading or the resistance reading is greater than zero ohms, replace the switch.
	6. Defective Blocked Inlet switch.	6. Turn off unit and check the continuity of the Blocked Inlet switch. If there is an erratic resistance reading or the resistance reading is greater than zero ohms, replace the switch.
	7. Bad inlet air temperature sensor.	7. Check the actual inlet air temperature reading and measure resistance at the Sensor Harness connection P1. Verify that the reading conforms to the values shown in Appendix B: <i>Temperature Sensor Resistance/Voltage Chart</i> .
	8. Defective temperature sensor.	8. Refer to CORRECTIVE ACTION 7 and verify that the voltage conforms to the values shown in Appendix B: <i>Temperature Sensor Resistance/Voltage Chart</i> .
	9. Loose wire connection between the Blower and the Controller.	9. Check wire connection from the Blower motor to the Secondary Power Panel.
	10. Defective Air-Fuel Valve potentiometer.	10. Check Air/Fuel Valve position at 0%, 50% and 100% open positions. The positions on the Valve Position bar graph should match the readings on the Air/Fuel Valve dial.
	11. Hard light.	11. Check igniter-injector for soot or erosion of electrode. Check injector solenoid valve to insure proper open/close operation.
AIRFLOW FAULT DURING PURGE	1. Blower not running or running too slow.	1. Start the unit. If the blower doesn't run, check the blower solid state relay for input and output voltage. If OK, check the blower.
	2. Defective Blocked Inlet switch.	2. Start the unit. If the blower runs, turn off unit and check the Blocked Inlet switch for continuity. Replace the switch if continuity does not exist.
	3. Blockage in air filter or Blocked Inlet switch.	3. Remove the air filter and Blocked Inlet switch and inspect for signs of blockage. Clean or replace as necessary.

Centurion Troubleshooting Procedures		
Fault	Probable Causes	Corrective Action
	4. Blocked blower inlet or inlet ductwork.	4. Inspect the inlet to the combustion blower including any ductwork leading up to the combustion blower for signs of blockage.
	5. No voltage to Blocked Inlet switch from Edge Controller.	5. During the start sequence, verify that 24 VAC is present between each side of the switch and ground. If 24 VAC is not present, refer fault to qualified service personnel.
	6. PROBABLE CAUSES from 3 to 12 for AIRFLOW FAULT DURING IGNITION apply for this fault.	6. See CORRECTIVE ACTIONS for AIRFLOW FAULT DURING IGNITION, items 3 to 12.
	7. Missing or improperly connected Blocked Flue jumper.	7. Check auxiliary box to be sure Blocked Flue input is jumpered and properly connected.
AIRFLOW FAULT DURING RUN	1. Blower stopped running due to thermal or current overload.	1. Check blower for signs of excessive heat or high current draw that may trip thermal or current overload devices.
	2. Blocked Blower inlet or inlet ductwork.	2. Inspect the inlet to the blower, including any ductwork leading up to the combustion blower, for signs of blockage.
	3. Blockage in air filter or Blocked Inlet switch.	3. Remove the air filter and Blocked Inlet switch and inspect for signs of blockage, clean or replace as necessary.
	4. Defective Blocked Inlet switch.	4. Verify that 24 VAC is present between each side of the switch and ground. If 24 VAC is not present at both sides, replace switch.
	5. Combustion oscillations.	5. Run unit to full fire. If the unit rumbles or runs rough, perform combustion calibration.
	6. Probable causes from 3 to 16 for AIRFLOW FAULT DURING IGNITION applies for this fault.	6. See CORRECTIVE ACTIONS from 3 to 12 for AIRFLOW FAULT DURING IGNITION.
DELAYED INTERLOCK OPEN	1. Delayed Interlock Jumper not properly installed or missing.	1. Check to insure jumper is properly installed across the Delayed Interlock terminals in the I/O Box.
	2. Device proving switch hooked to interlocks is not closed.	2. If there are 2 external wires on these terminals, check if an end switch for a proving device (such as a pump, louver, etc.) is tied to the interlocks. Ensure the device and/or its end switch is functional. A jumper may be temporarily installed to test the interlock.

Centurion Troubleshooting Procedures		
Fault	Probable Causes	Corrective Action
DIRECT DRIVE SIGNAL FAULT	1. Direct drive signal is not present: <ul style="list-style-type: none"> • Not yet installed. • Wrong polarity. • Signal defective at source. • Broken or loose wiring. 	1. Check I/O Box to ensure signal is hooked up. <ul style="list-style-type: none"> • Hook up if not installed. • If installed, check polarity. • Measure signal level. • Check wiring continuity between source and unit.
	2. Signal is not isolated (floating).	2. Check signal at source to ensure it is isolated.
	3. Edge Controller signal type selection switches not set for correct signal type (voltage or current).	1. Check DIP switch on the Controller's Interface board to ensure it is set correctly for the type of signal being sent. Check control signal type set in Advanced Setup → WHM Cascade → Application Configuration screen.
FLAME LOSS DURING IGN	1. Worn Flame Detector.	1. Remove and inspect the Flame Detector for signs of wear. Replace if necessary.
	2. No spark from Spark Igniter.	2. Close the internal gas valve in the unit. Install and arc a spark igniter outside the unit.
	3. Defective Ignition Transformer.	3. If there is no spark, check for 120 VAC at the primary side to the ignition transformer during the ignition cycle.
	4. Defective Ignition/Stepper (IGST) Board.	4. If 120 VAC is not present, the IGST Board in the Edge Controller may be defective. Refer fault to qualified service personnel.
	5. Defective SSOV.	5. While externally arcing the spark igniter, observe the open/close indicator in the Safety Shut-Off Valve to ensure it is opening. If the valve does not open, check for 120 VAC at the valve input terminals. If 120 VAC isn't present, the Edge Controller's IGST board may be defective. Refer fault to qualified service personnel.
FLAME LOSS DURING RUN	1. Worn Flame Detector or cracked ceramic.	1. Remove and inspect the Flame Detector for signs of wear or cracked ceramic. Replace if necessary.
	2. Defective Regulator.	2. Check gas pressure readings using a gauge or manometer into and out of the Air/Fuel Valve to ensure that the gas pressure into and out of the valve is correct.
	3. Poor combustion calibration.	3. Check combustion calibration using the procedures in Section 5.4: <i>Combustion Calibration</i> of this guide.
	4. Debris on burner.	4. Remove the burner and inspect for any carbon build-up or debris. Clean and reinstall.
	5. Blocked condensate drain.	5. Remove blockage in condensate drain.
HEAT DEMAND FAILURE	1. The Heat Demand Relays on the Ignition/Stepper (IGST) board failed to activate when commanded.	1. Press CLEAR button and restart the unit. If the fault persists, replace Ignition/Stepper (IGST) Board.

Centurion Troubleshooting Procedures		
Fault	Probable Causes	Corrective Action
	2. Relay is activated when not in Demand.	2. Defective relay. Replace IGST Board.
HIGH EXHAUST TEMPERATURE	1. Poor combustion calibration.	1. Check combustion calibration using procedures in Section 5.4: <i>Combustion Calibration</i> of this guide.
	2. Carboned heat exchanger due to incorrect combustion calibration.	2. If exhaust temperature is greater than 200°F (93.3°C), check combustion calibration. Calibrate or repair as necessary.
HIGH GAS PRESSURE	1. Incorrect supply gas pressure.	1. Check to ensure gas pressure at inlet of SSOV does not exceed 14" W.C. (3.49 kPa).
	2. Defective SSOV Actuator.	2. If gas supply pressure downstream of SSOV Actuator cannot be lowered to below 2.5" W.C. (622 Pa); the SSOV Actuator may be defective.
	3. Defective High Gas Pressure switch.	3. Remove the leads from the High Gas Pressure switch. Measure continuity across the common (C) and normally closed (NC) terminals with the unit not firing. Replace the switch if continuity does not exist.
HIGH WATER TEMP SWITCH OPEN	1. Faulty Water temperature switch.	1. Test the temperature switch to insure it trips at its actual water temperature setting.
	2. Incorrect PID settings.	2. Check PID settings (Advanced Setup → Performance → Temperature Control, first 3 items). If the settings have been changed, record the current readings then reset to default values.
	3. Faulty shell temperature sensor.	3. Using the resistance charts in Appendix B: <i>Temperature Sensor Resistance/Voltage Chart</i> measure the resistance of Shell sensor and BTU sensor at a known water temperature.
	4. Unit in Manual mode.	4. If unit is in Manual mode, switch to Auto mode (Diagnostic → Manual Run, Manual Mode).
	5. Unit setpoint is greater than Over Temperature switch setpoint.	5. Check setpoint of unit and setpoint of Temperature switch; Ensure that the temperature switch is set higher than the unit's setpoint.
	6. System flow rate changes are occurring faster than units can respond.	6. If system is a variable flow system, monitor system flow changes to ensure that the rate of flow change is not faster than what the units can respond to.
HIGH WATER TEMPERATURE	1. See High Water Temperature Switch Open.	1. See High Water Temperature Switch Open.
	2. Temp HI Limit setting is too low.	2. Check Temp HI Limit setting.
IGN BOARD COMM FAULT	1. Communication fault has occurred between the PMC board and Ignition/Stepper (IGST) board.	1. Press CLEAR button and restart unit. If fault persists, contact qualified Service Personnel.
	2. 32 Pin Ribbon cable defective.	2. Replace 32 Pin Ribbon cable.

Centurion Troubleshooting Procedures		
Fault	Probable Causes	Corrective Action
IGN SWITCH CLOSED DURING PURGE	1. Air/Fuel Valve not rotating.	1. Start the unit. The Air/Fuel Valve should rotate to the purge (open) position. If the valve does not rotate at all or does not rotate fully open, check the Air/Fuel Valve calibration. If calibration is okay, the problem may be in the Air-Fuel Valve or the Edge Controller. Refer to qualified service personnel.
	2. Defective or shorted switch.	2. If the Air/Fuel Valve does rotate to purge, check the ignition switch for continuity between the N.O. and COM terminals. If the switch shows continuity when not in contact with the cam replace the switch.
	3. Switch wired incorrectly.	3. Check to ensure that the switch is wired correctly (correct wire numbers on the normally open terminals). If wired correctly, replace switch.
	4. Defective Power Supply Board or fuse.	4. Check DS1 & DS2 LEDs on Power Supply Board. If not steady ON, replace Power Supply Board.
	5. Defective IGST Board.	5. Check "Heartbeat" LED DS1 and verify it is blinking ON & OFF every second. If not, replace IGST Board.
IGN SWITCH OPEN DURING IGNITION	1. Air/Fuel Valve not rotating to ignition position.	1. Start the unit. The Air/Fuel Valve should rotate to the purge (open) position, then back to ignition position (towards closed) during the ignition cycle. If the valve does not rotate back to the ignition position, check the Air/Fuel Valve calibration. If calibration is okay, the problem may be in the Air/Fuel Valve or the Controller. Refer fault to qualified service personnel.
	2. Defective Ignition switch.	2. If the Air/Fuel Valve does rotate to the ignition position, check the ignition position switch for continuity between the N.O. and COM terminals when in contact with the cam.
	3. Defective Power Supply Board or fuse.	3. Check DS1 & DS2 LEDs on Power Supply Board. If not steady ON, replace Power Supply Board.
	4. Defective IGST Board.	4. Check "Heartbeat" LED DS1 and verify it is blinking ON & OFF every second. If not, replace IGST Board.
INTERLOCK OPEN	1. Interlock jumper not installed or removed.	1. Check for a jumper properly installed across the interlock terminals in the I/O box.
	2. Energy Management System does not have unit enabled.	2. 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).
	3. Device proving switch hooked to interlocks is not closed.	3. Check that proving switch for any device hooked to the interlock circuit is closing and that the device is operational.
LINE VOLTAGE OUT OF PHASE	1. Line and Neutral switched in AC Power Box.	1. Check hot and neutral in AC Power Box to ensure they are not reversed.

Centurion Troubleshooting Procedures		
Fault	Probable Causes	Corrective Action
	2. Incorrect power supply transformer wiring.	2. Check transformer wiring, in AC Power Box, against the power box transformer wiring diagram to ensure it is wired correctly.
LOW GAS PRESSURE	1. Incorrect supply gas pressure.	1. Measure gas pressure upstream of the SSOV Actuator(s) with the unit firing. Ensure it is above 4.0" W.C. (995 Pa) for FM gas train and 4.5" W.C. (1,112 Pa) for DBB gas train at full fire.
	2. Defective Low Gas Pressure switch.	2. Measure pressure at Low Gas Pressure switch. If greater than 1 inch above Low Gas Pressure switch setting, measure continuity across the switch and replace if necessary.
LOW WATER LEVEL	1. Insufficient water level in system.	1. Check system for sufficient water level.
	2. Defective water level circuitry.	2. 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.
	3. Defective water level probe.	3. Check continuity of probe end to the shell, change probe if there is no continuity.
MODBUS COMMFAULT	Unit not seeing information from Modbus network.	Check network connections. If fault persists, contact qualified Service Personnel.
PRG SWITCH CLOSED DURING IGNITION	1. A/F Valve rotated open to purge and did not rotate to ignition position.	1. Start the unit. The Air/Fuel Valve should rotate to the purge (open) position, then back to ignition position (towards closed) during the ignition cycle. If the valve does not rotate back to the ignition position, check the Air/Fuel Valve calibration. If calibration is okay, the problem may be in the Air/Fuel Valve or the Edge Controller. Refer fault to qualified service personnel.
	2. Defective or shorted switch.	2. If the Air/Fuel Valve does rotate to the ignition position, check the purge switch for continuity between the N.O. and COM terminals. If the switch shows continuity when not in contact with the cam, check to ensure that the switch is wired correctly (correct wire numbers on the normally open terminals).
	3. Switch wired incorrectly.	3. If the switch is wired correctly, replace the switch.
	4. Defective Power Supply Board or fuse.	4. Check DS1 & DS2 LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board.
	5. Defective IGST Board.	5. Check "Heartbeat" LED DS1 and verify it is blinking ON & OFF every second. If not, replace IGST Board.
PRG SWITCH OPEN DURING PURGE	1. Defective Purge switch.	1. If the air-fuel valve does rotate, check Purge switch for continuity when closing. Replace switch if continuity does not exist.

Centurion Troubleshooting Procedures		
Fault	Probable Causes	Corrective Action
	2. No voltage present at switch.	2. Measure for 24 VAC from each side of the switch to ground. If 24 VAC is not present, refer fault to qualified service personnel.
	3. Switch wired incorrectly.	3. Check to ensure that the switch is wired correctly (correct wire numbers on the normally open terminals).
	4. Defective Power Supply Board or fuse.	4. Check DS1 & DS2 LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board.
	5. Defective IGST Board.	5. Check "Heartbeat" LED DS1 and verify it is blinking ON & OFF every second. If not, replace IGST Board.
OUTDOOR TEMP SENSOR FAULT	1. Loose or broken wiring.	1. Inspect Outdoor Temperature sensor for loose or broken wiring.
	2. Defective Sensor.	2. Check resistance of sensor to determine if it is within specification.
	3. Incorrect Sensor.	3. Ensure that the correct sensor is installed.
RECIRC PUMP FAILURE	1. Internal recirculation pump failed.	1. Replace recirculation pump.
REMOTE SETPT SIGNAL FAULT	1. Remote setpoint signal not present: <ul style="list-style-type: none"> • Not yet installed. • Wrong polarity. • Signal defective at source. • Broken or loose wiring. 	1. Check I/O Box to ensure signal is hooked up. <ul style="list-style-type: none"> • Hook up if not installed. • If installed, check polarity. • Measure signal level. • Check continuity of wiring between source and unit.
	2. Signal is not isolated (floating) if 4 to 20 mA.	2. Check signal at source to ensure it is isolated.
	3. Edge Controller signal type selection switches not set for correct signal type (voltage or current).	3. Check DIP switch on PMC board to ensure it is set correctly for the type of signal being sent. Check control signal type set in the Remote Signal parameter (Advanced Setup → Unit → Application Configuration).
RESIDUAL FLAME	1. Defective Flame Detector.	1. Replace Flame Detector.
	2. SSOV not fully closed.	2. Check open/close indicator window of Safety Shut-Off Valve (SSOV) and ensure that the SSOV is fully closed. If not fully closed, replace the valve and or actuator. Close the Gas Shut-Off Valve downstream of SSOV. Install a manometer or gauge at the leak detection port between the SSOV and Gas Shut Off Valve. If a gas pressure reading is observed replace the SSOV Valve and/or Actuator.
	3. Wire strand from burner head in contact with Flame Detector	3. Ensure Flame Detector is in good condition and is not tilted inward toward burner head.
SSOV FAULT DURING PURGE	See SSOV SWITCH OPEN	

Centurion Troubleshooting Procedures		
Fault	Probable Causes	Corrective Action
SSOV FAULT DURING RUN	SSOV switch closed for 15 seconds during run.	1. Replace actuator.
SSOV RELAY FAILURE	1. SSOV relay failed on IGST board.	1. Press CLEAR button and restart unit. If fault persists, replace Ignition/Stepper (IGST) Board.
	2. Floating Neutral.	2. The Neutral and Earth Ground are not connected at the source and therefore there is a voltage measured between the two. Normally this measurement should be near zero or no more than a few millivolts.
	3. Hot and Neutral reversed at SSOV.	3. Check SSOV power wiring.
SSOV SWITCH OPEN	1. Actuator not allowing for full closure of gas valve.	1. Observe operation of the Safety Shut-Off Valve (SSOV) through indicator on the Valve actuator and ensure that the valve is fully and not partially closing.
	2. SSOV powered when it should not be	2. If the SSOV never closes, it may be powered continuously. Close the gas supply and remove power from the unit. Refer fault to qualified service personnel.
	3. Defective switch or Actuator.	3. Remove the electrical cover from the SSOV and check switch continuity. If the switch does not show continuity with the gas valve closed, either adjust or replace the switch or actuator.
	4. Incorrectly wired switch.	4. Ensure that the SSOV Proof of Closure switch is correctly wired.
STEPPER MOTOR FAILURE	1. Air/Fuel Valve unplugged.	1. Check that the Air/Fuel Valve is connected to the Edge Controller.
	2. Loose wiring connection to the stepper motor.	2. Inspect for loose connections between the Air/Fuel Valve motor and the wiring harness.
	3. Defective Air/Fuel Valve stepper motor.	3. Replace stepper motor.
	4. Defective Power Supply Board or fuse.	4. Check DS1 & DS2 LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board.
	5. Defective IGST Board.	5. Check "Heartbeat" LED DS1 and verify it is blinking ON & OFF every second. If not, replace IGST Board.
	6. Air/Fuel Valve out of calibration	6. Perform the stepper motor calibration procedure (Main Menu → Diagnostics → Subsystems → Air Fuel Valve Stepper Motor).

10.2 Additional Faults Without Specific Fault Messages

Refer to Table 12.2 to troubleshoot faults which may occur without a specific fault message being displayed.

TABLE 12.2: Water Heater Troubleshooting with No Fault Message Displayed		
Observed Incident	Probable Causes	Corrective Action
Hard Light-Off	1. Clogged/damaged Gas Injector on Igniter-Injector (Figure 7.2-1).	1. Disconnect the Staged Ignition Assembly solenoid from the Gas injector Tube of the Igniter-Injector (Figure 7.2-1) and inspect Gas Injector to ensure it is not clogged or damaged.
	2. Defective Staged Ignition Solenoid (Figure 7.2-1).	2. Close the Manual Shutoff Valve. Attempt to start the unit and listen for a “clicking” sound that the Staged Ignition Solenoid makes during Ignition Trial. If “clicking” sound is not heard after 2 or 3 attempts, replace the Staged Ignition Solenoid.
Fluctuating Gas Pressure	1. Gas pressure going into unit is fluctuating.	1. Stabilize gas pressure going into unit. If necessary, troubleshoot Building Supply Regulator.
	2. Damping Orifice not installed.	2. Check if the gas train is supposed to have a Damping Orifice, and if so, ensure that it is installed in the SSOV Actuator, as shown in Figure 10.2-3, below.

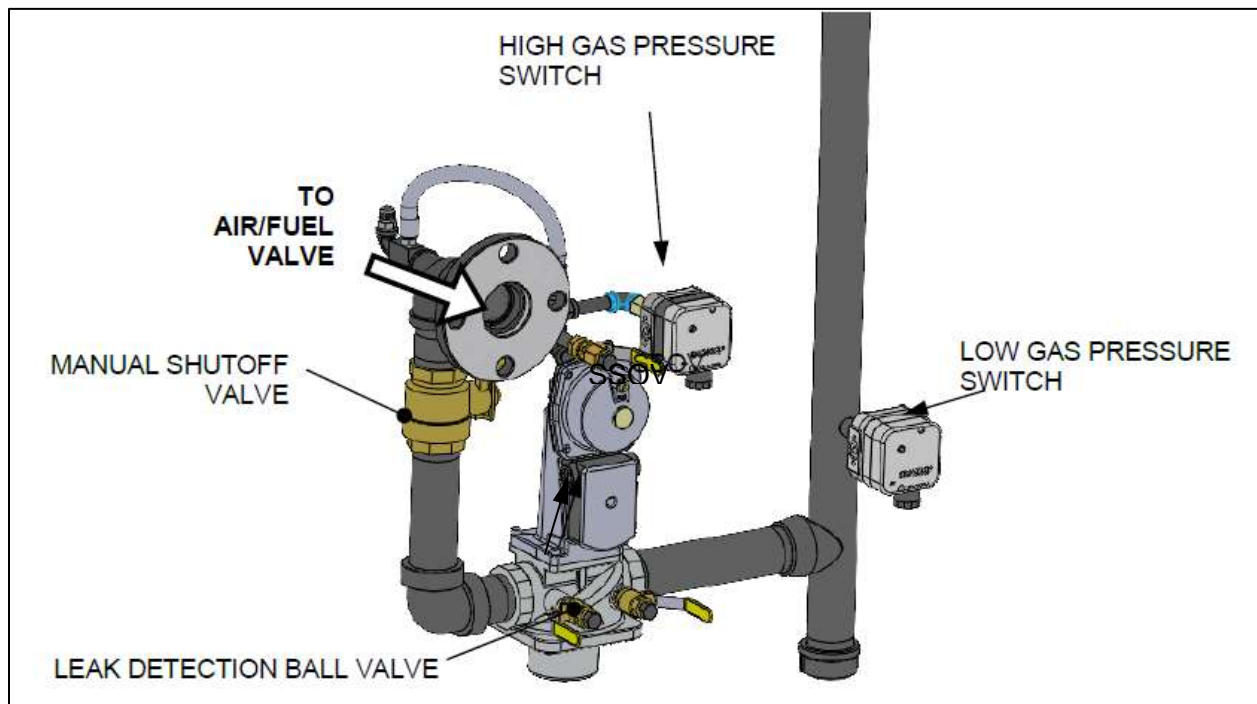


Figure 10-1: Gas Train Component Locations (P/N 22362C Shown)

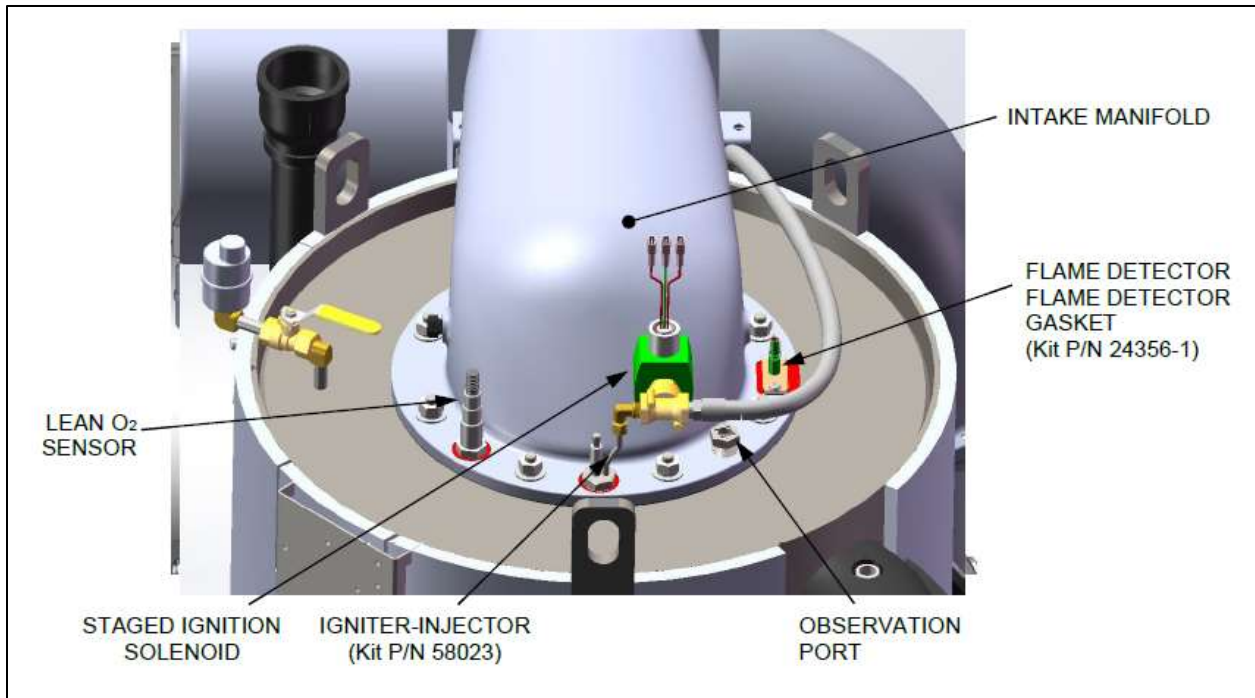
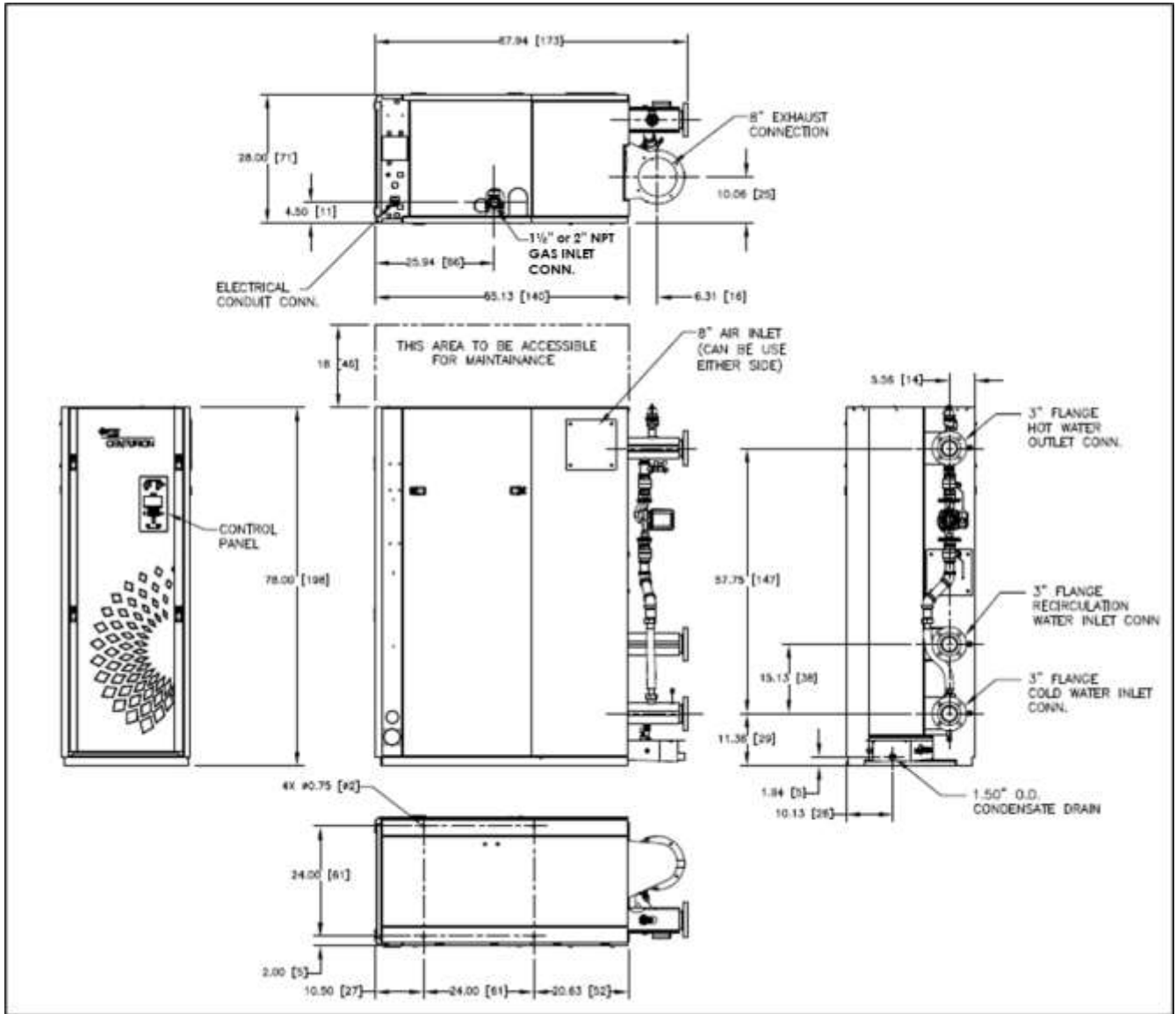


Figure 10-2: Intake Manifold and Components

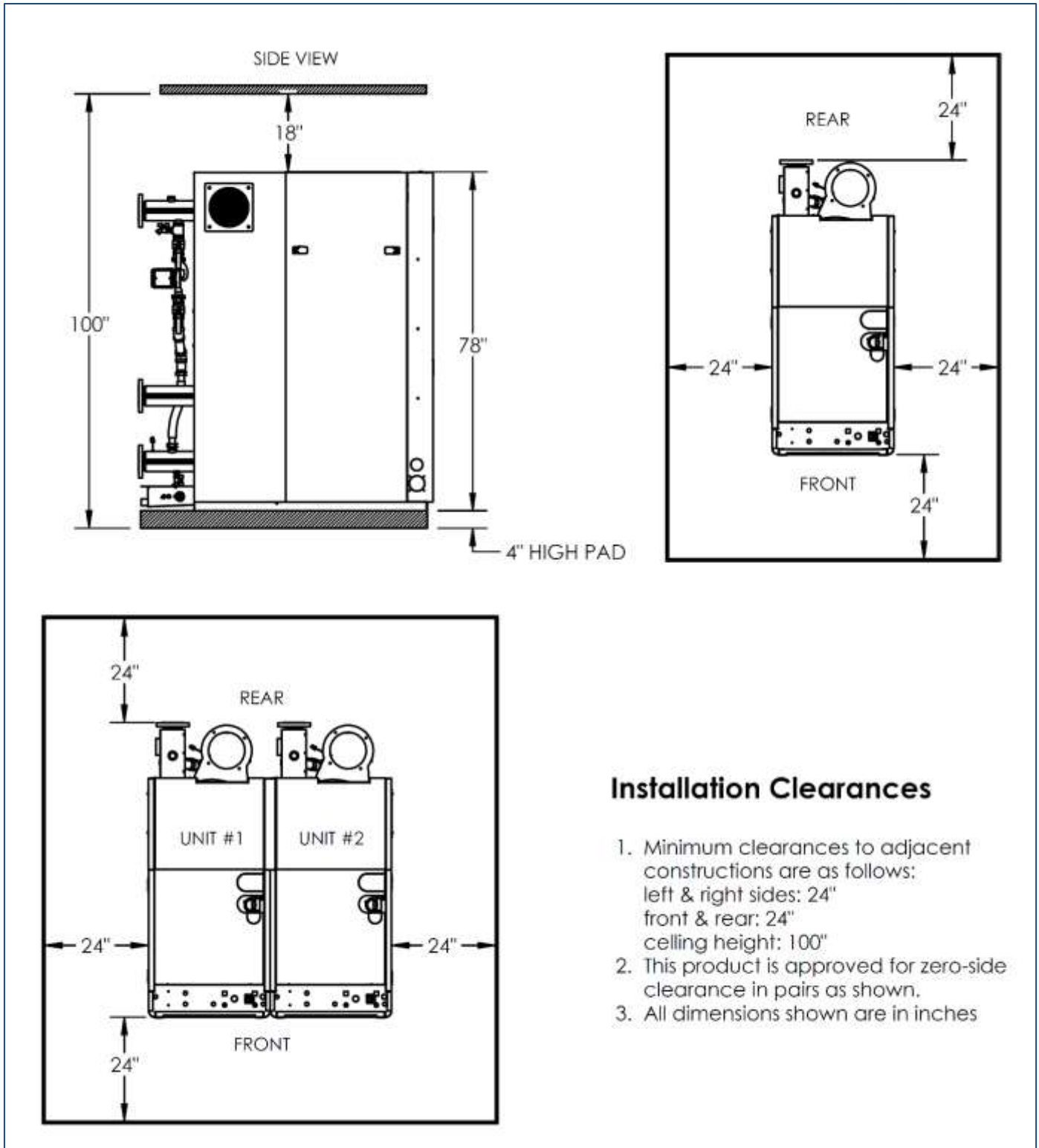


Figure 10-3: SSOV Actuator with Gas Pressure Adjustment (SKP25)

APPENDIX A – DIMENSIONS AND CLEARANCE



Centurion Dimensions (CEN 2000 & CEN 1600)

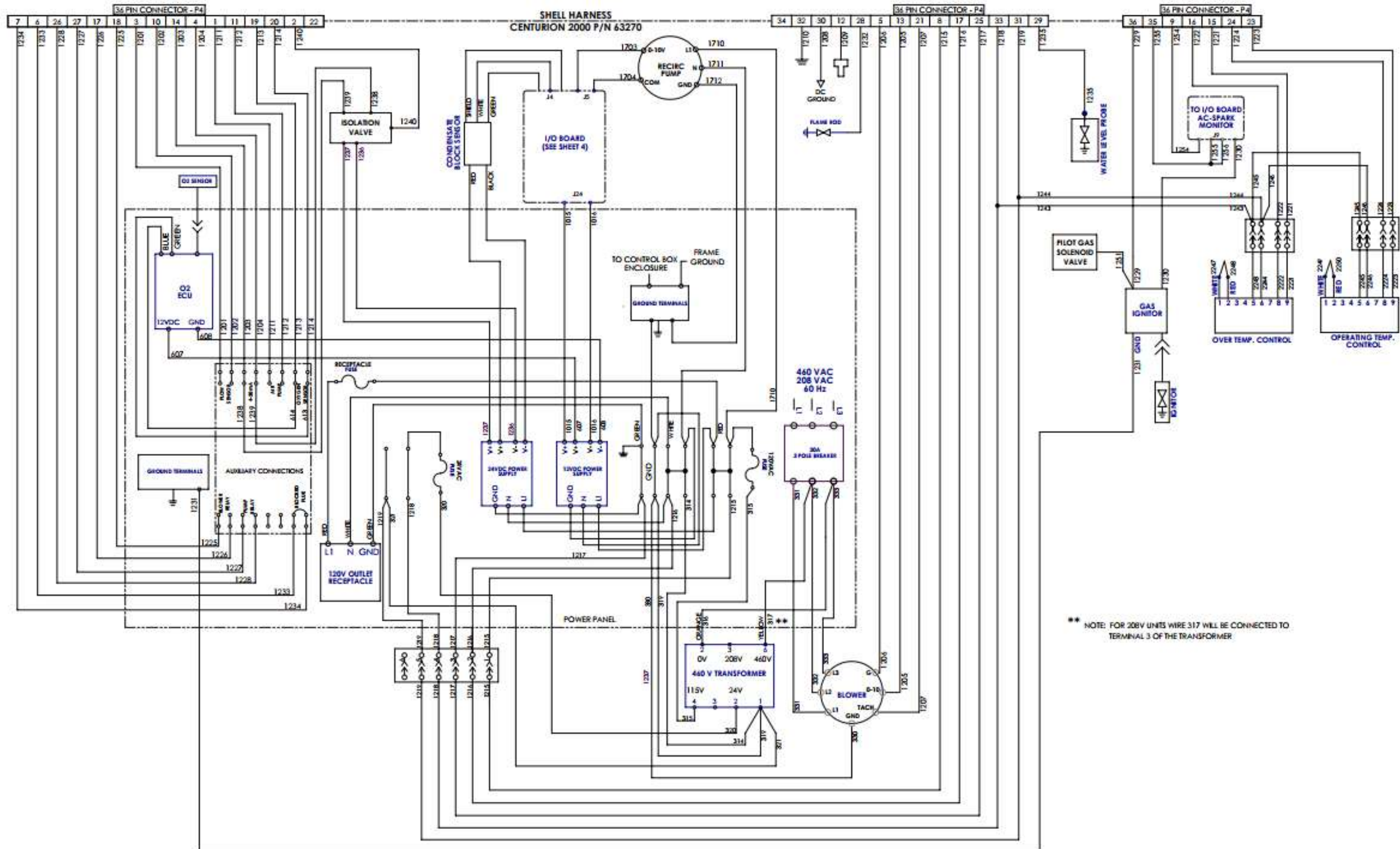


Installation Clearances

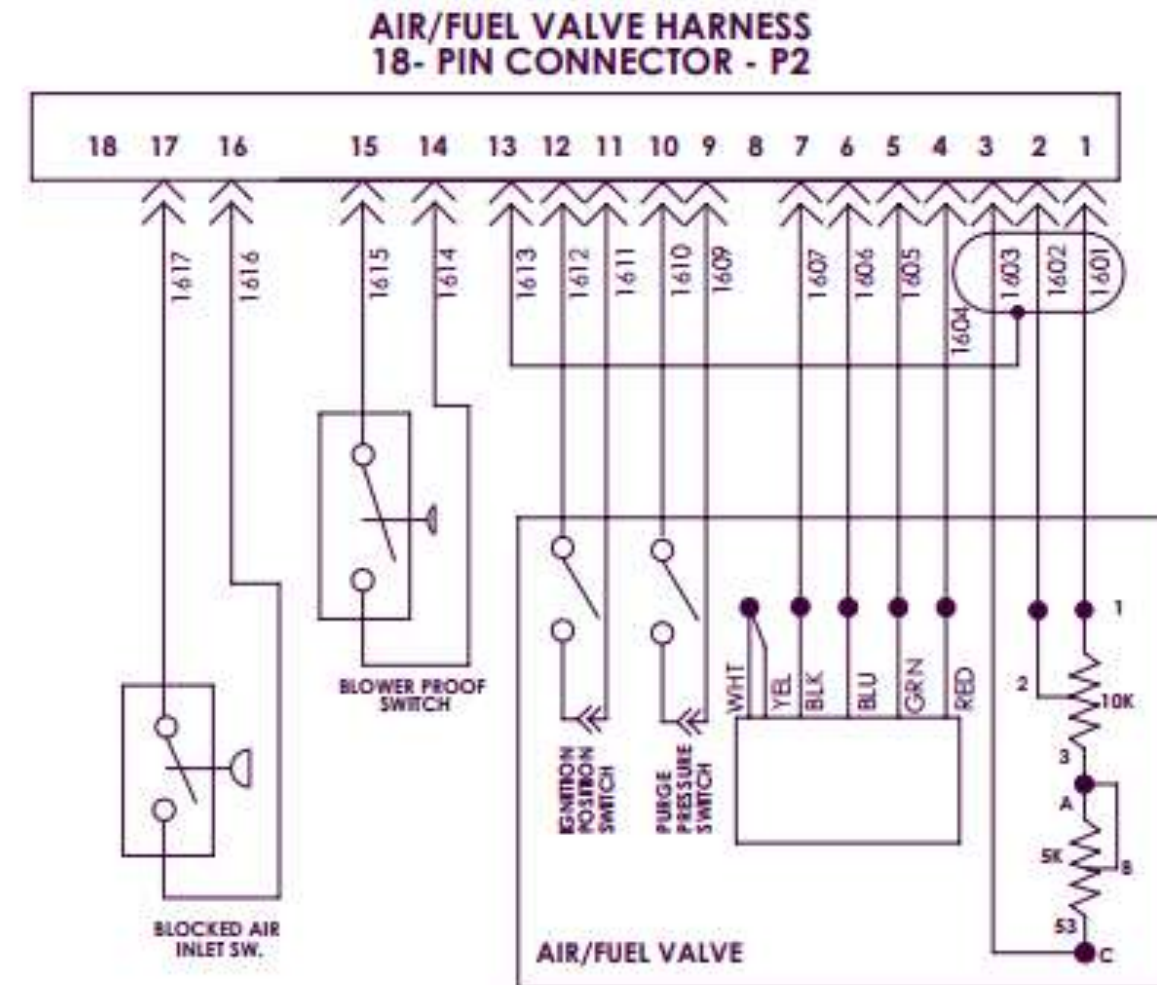
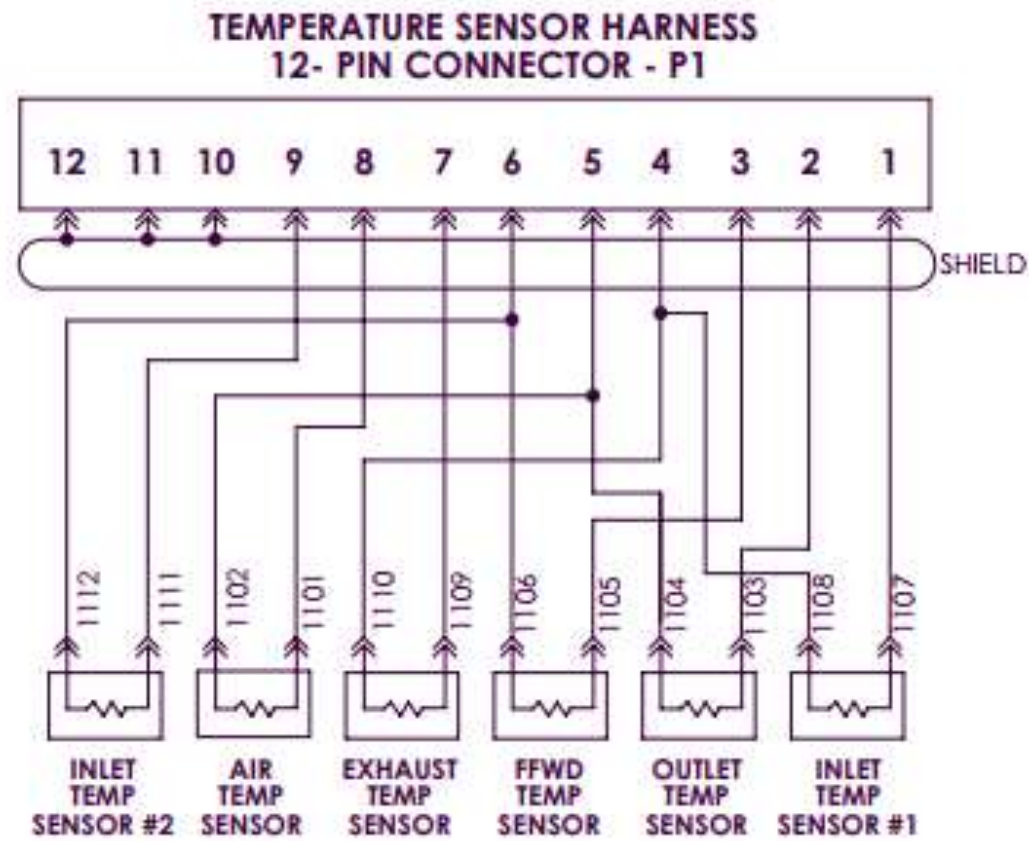
1. Minimum clearances to adjacent constructions are as follows:
 left & right sides: 24"
 front & rear: 24"
 ceiling height: 100"
2. This product is approved for zero-side clearance in pairs as shown.
3. All dimensions shown are in inches

Centurion Clearances (CEN 2000 & CEN 1600)

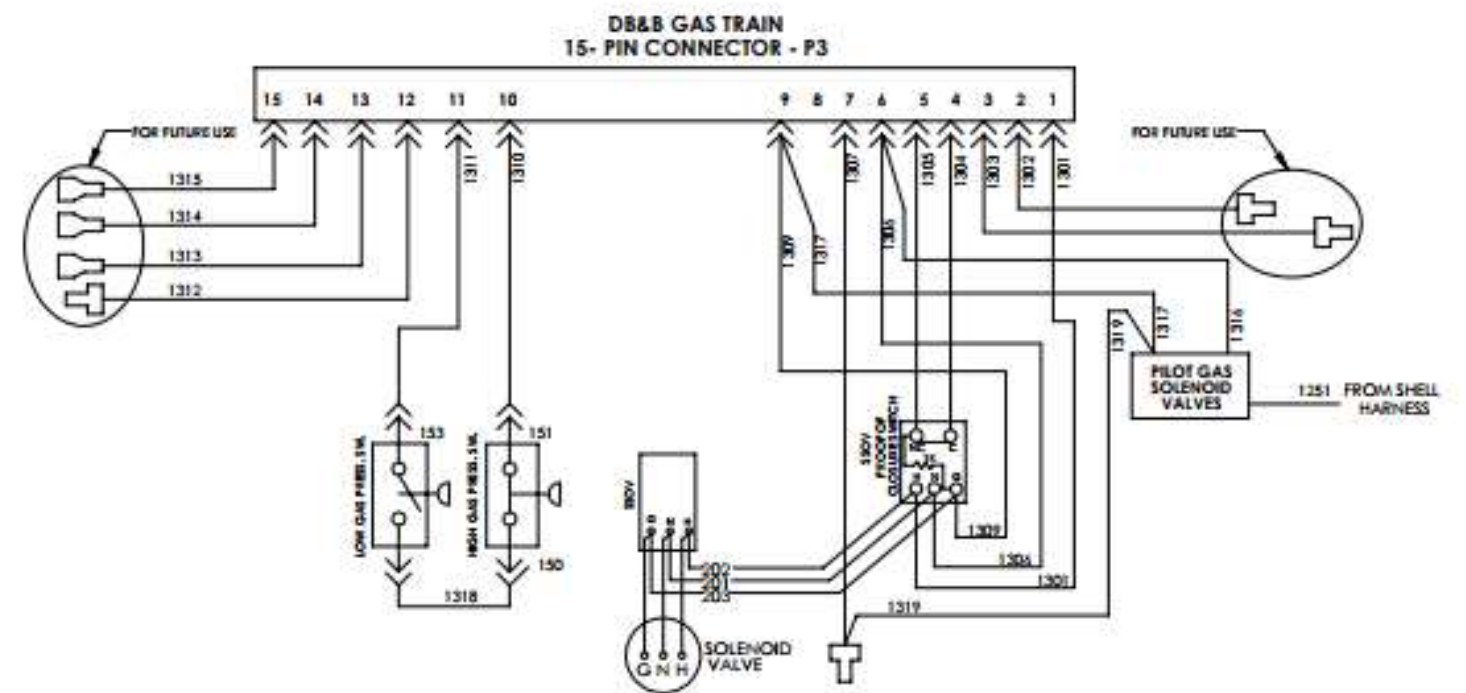
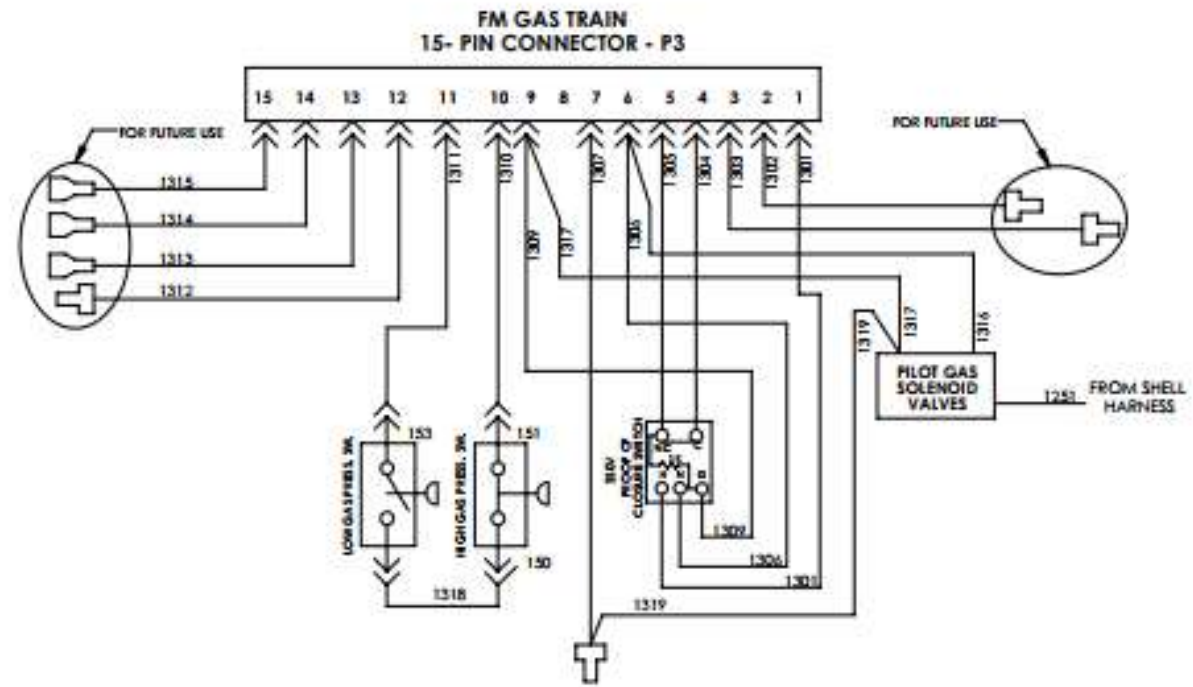
APPENDIX B – WIRING DIAGRAMS



Centurion 2000 – Drawing Number: 68106 rev C Sheet 1 of 4



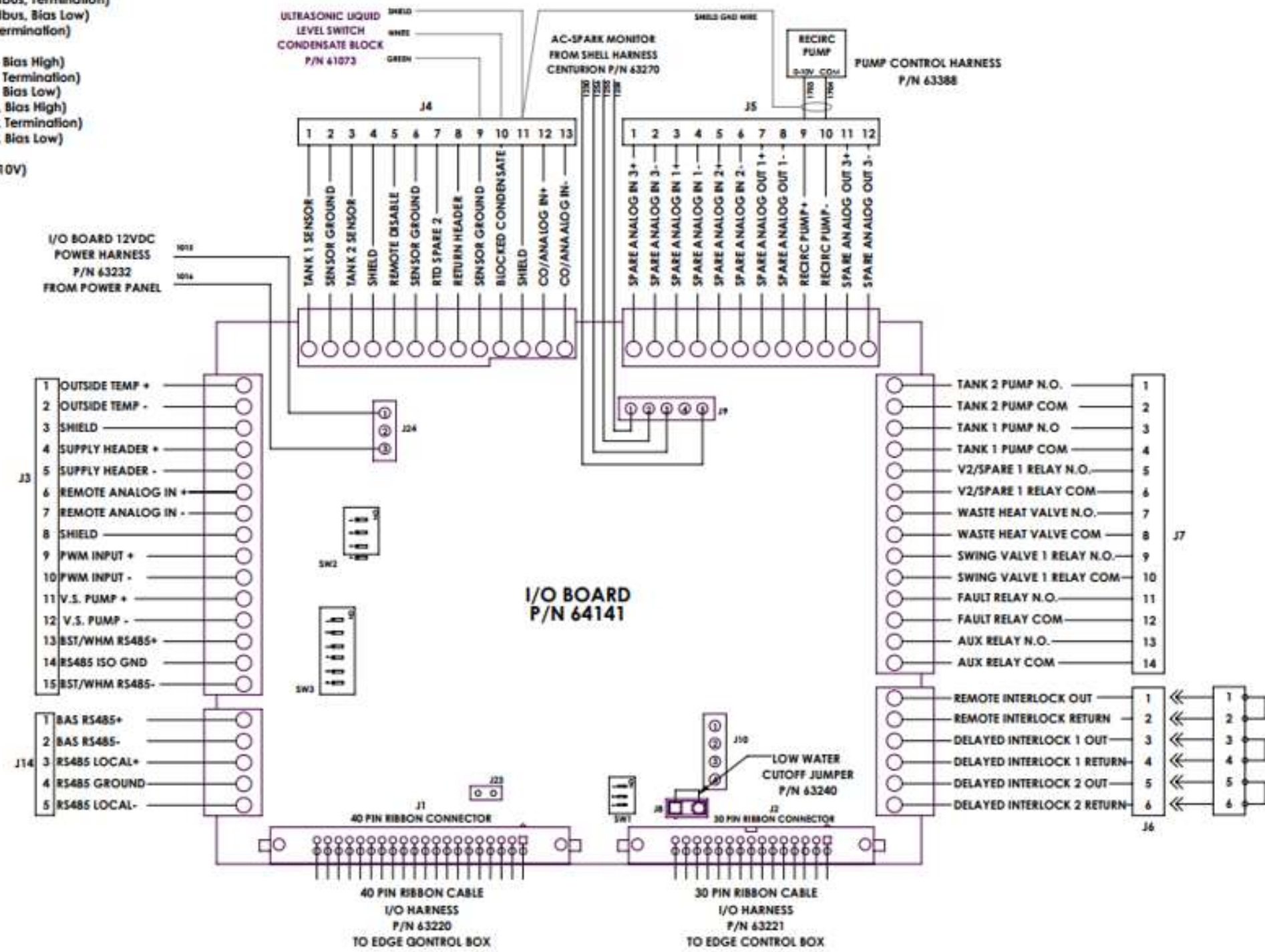
Centurion 2000 – Drawing Number: 68106 rev C Sheet 2 of 4



Centurion 2000 – Drawing Number: 68106 rev C Sheet 3 of 4

**DIP SWITCHES & JUMPERS
 (FACTORY DEFAULT POSITION SHOWN)**

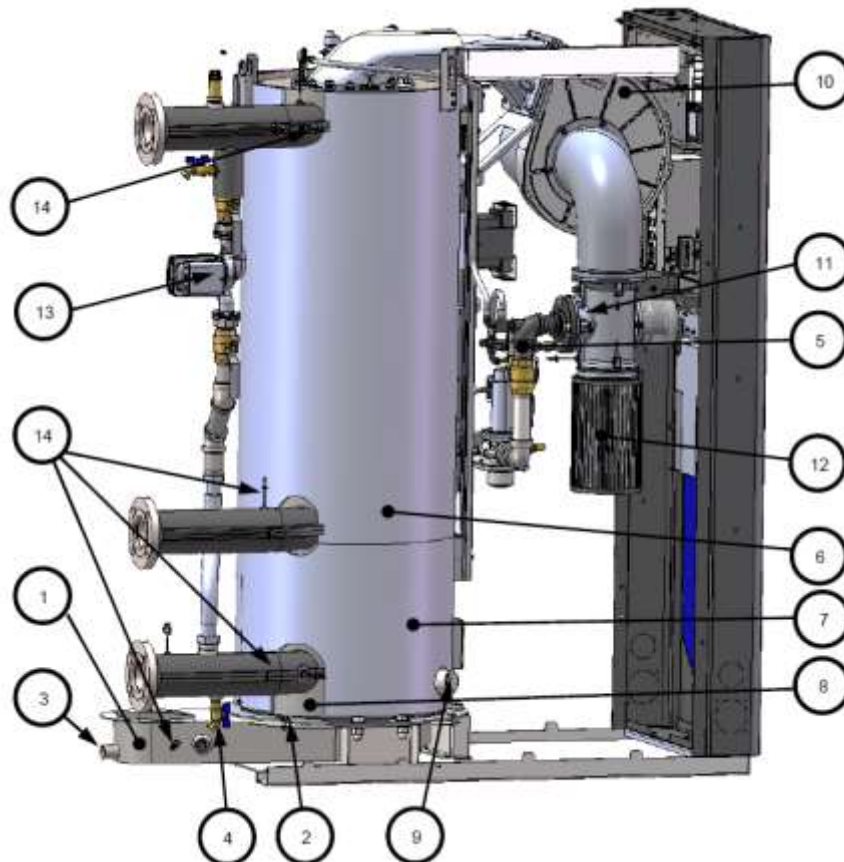
- SW1-1: On (Unused)
- SW1-2: On (Unused)
- SW1-3: On (Unused)
- SW2-1: Off (RS485 Modbus, Bias High)
- SW2-2: Off (RS485 Modbus, Termination)
- SW2-3: Off (RS485 Modbus, Bias Low)
- SW2-4: Off (CANBUS, Termination)
- SW3-1: Off (RS485 NET, Bias High)
- SW3-2: Off (RS485 NET, Termination)
- SW3-3: Off (RS485 NET, Bias Low)
- SW3-4: Off (RS485 BAS, Bias High)
- SW3-5: Off (RS485 BAS, Termination)
- SW3-6: Off (RS485 BAS, Bias Low)
- J23: On (ISO Valve, 0-10V)



Centurion 2000 – Drawing Number: 68106 rev C Sheet 4 of 4

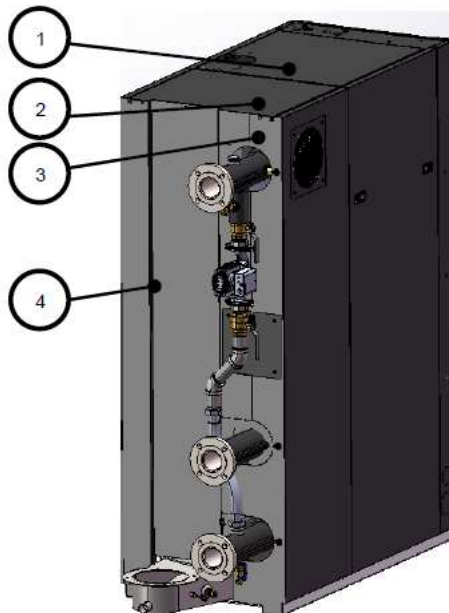
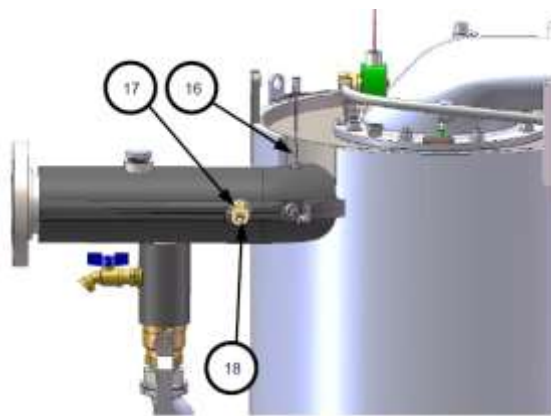
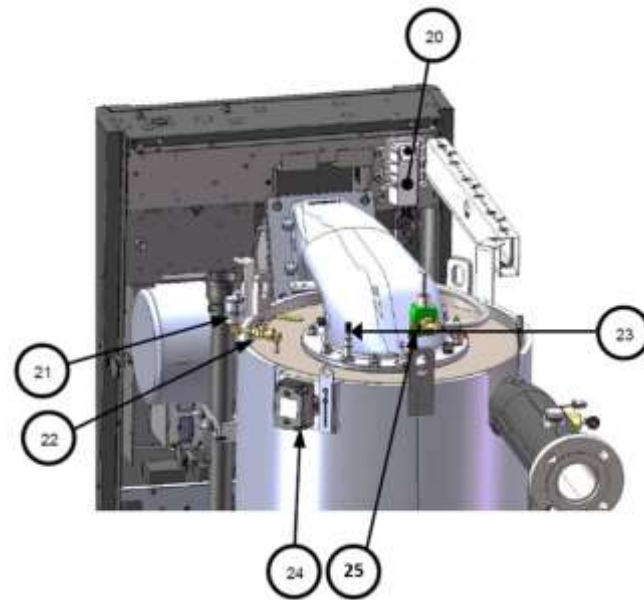
APPENDIX C – CENTURION2000/1600 PARTS LIST

Item #	Qty	Part #	Description
EXHAUST MANIFOLD			
1	1	39237	Exhaust Manifold
2	1	81165	Exhaust Manifold Seal
3	1	9-22	Pipe Plug - Exhaust Manifold
4	1	92094	Drain Valve: 3/4 "
GAS TRAIN ASSEMBLIES (See full diagram below)			
5	1	22362	CEN 2000/1600 Standard Gas Train
		22442	CEN 2000/1600 DBB Gas Train
HEAT EXCHANGER			
6	1	80081	Shell Insulation, Upper
7	1	80128	Shell Insulation, Lower
8	1	28752	CEN 2000/1600 Heat Exchanger – Dual Inlet
9	2	93748	Plug, 1-1/2" Brass
BURNER-BLOWER-A/F Valve (See full diagram below)			
10	1	26024-1	Burner-Blower Assy. (460 Voltage)
10	1	26024-2	Burner-Blower Assy. (208 Voltage)
11	1	88003	O-Ring, #2-339
12	1	88014	Air Filter, 6 x 12"
13	1	22384	Recirculation Assembly
14	4	61051	Directly Immersed Temperature Sensor, PT-1000

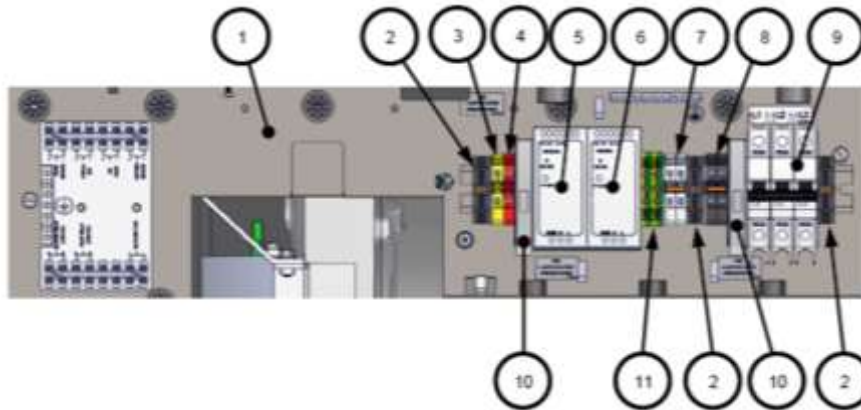


Item #	Qty	Part #	Description
16	1	61056	Temperature Sensor, Dual Thermocouple
18	1	122843 ❶	Low Water Cutoff
20	1	64081	ECU (for O ₂ Sensor)
21	1	59178	Vent: Air 1/8" NPT
22	1	123863	Valve: Ball 1/8" NPT
23	1	61026	O ₂ Sensor
24	1	65085	Ignition Transformer
25	1	124866	Staged Ignition Solenoid
26	1	66026 ❶	Ignitor-Injector

❶ Replacement Kit and/or Catalog number

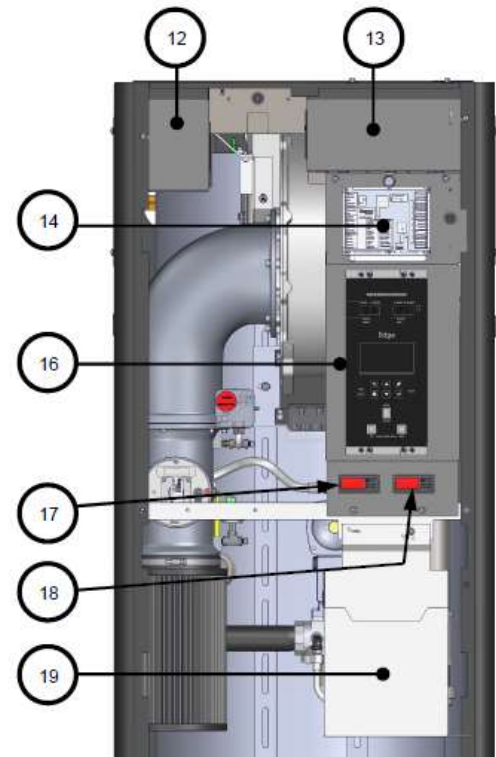


ENCLOSURE PANELS			
Item #	Qty	Part #	Description
1	1	30156	TOP PANEL: FRONT
2	1	30157	TOP PANEL: BACK
3	1	37148	BACK PANEL: LEFT
4	1	37149	BACK PANEL: RIGHT
7	1	39184-1	8" AIR INLET ADAPTER
8	8	59133	LATCH, COMPRESSION
9	1	25087-1	FRONT FRAME ASSEMBLY
10	2	30155	SIDE PANEL
11	1	25095	FRONT PANEL ASSEMBLY



**POWER PANEL
WITH COVERS REMOVED**

POWER PANEL P/N 69315-7			
Item #	Qty	Part #	Description
1	1	30170	Power Panel
2	3	69141	DIN Rail End Stop
3	1	65213	Terminal Block, Yellow
4	1	65194	Terminal Block, Red
5	1	65247	24 VDC Power Supply, 2.5 A
6	1	65231	12 V Power Supply, 5 A
7	2	65121	Terminal Block, White
8	2	65120	Terminal Block, Black
9	1	60036	3 Pole 20 Amp Circuit Breaker
10	2	65118	Fuse Terminal
11	2	65122	Terminal Ground Block
FRONT VIEW (Front panel removed)			
12	1	25090	Connection Panel Cover
13	1	25089	Power Panel Cover
14	1	64141	I/O Board, Edge
16	1	69344-1	Edge [ii] Control Panel 64142
17	1	64157	Temp Limit Control, Auto Reset
18	1	64155	Temp Limit Control, Manual Reset
19	1	33248	Literature Pocket



**PARTIAL FRONT VIEW
FRONT PANEL REMOVED**

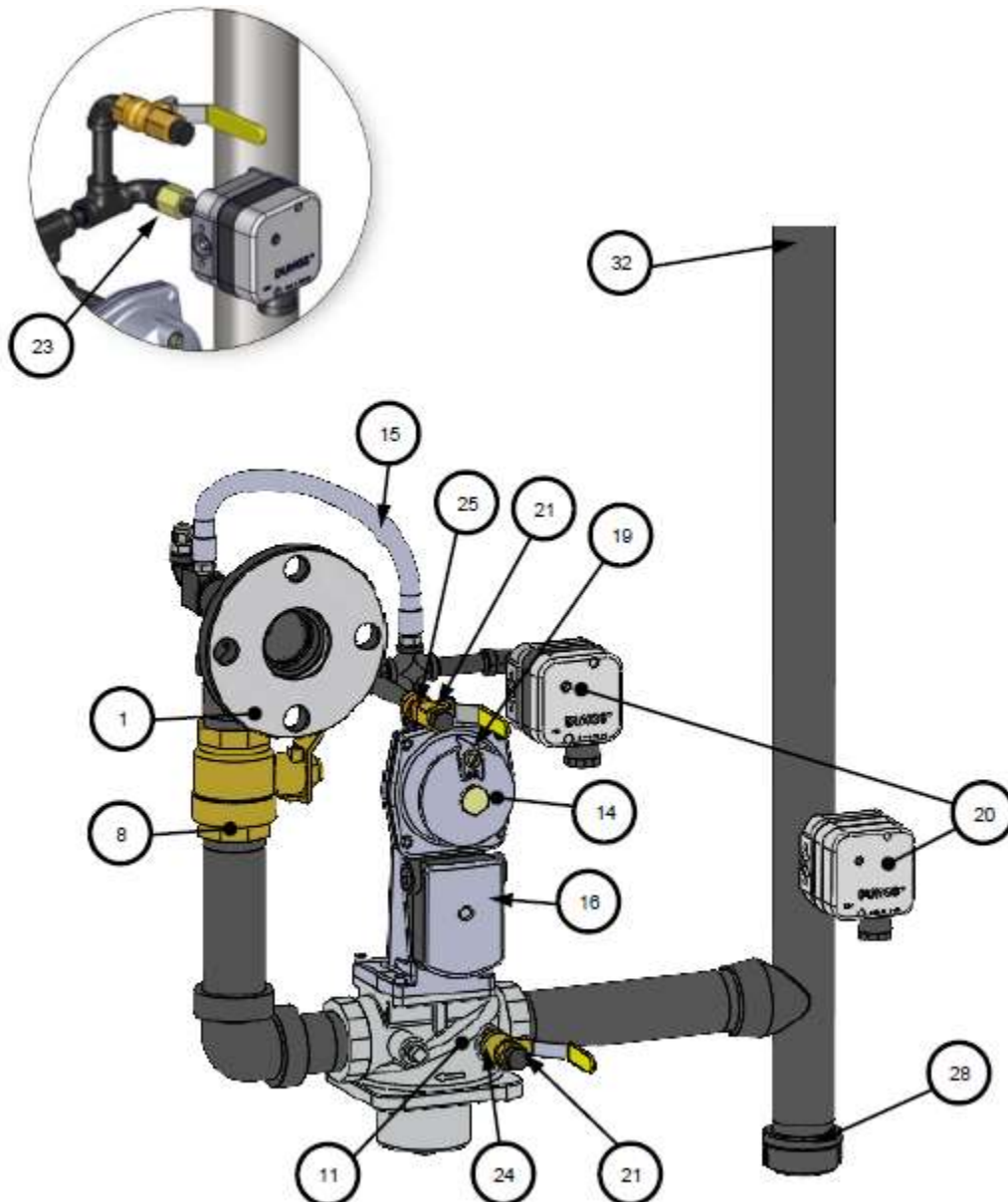
Centurion Spare Parts Kits	
Part #	Description
123540	Ball Valve, External 2"
24441	Condensate Trap
92605-5	T&P Relief Valve, pressure setting 150 psi, temperature setting 210°F
24786	8" Exhaust Connection for PVC/CPVC

Centurion Wiring Harnesses (not shown)	
Part #	Description
63059	HARNESS: BLOWER POWER
63083-1	HARNESS: O ₂ SENSOR
63121	HARNESS: 12V POWER SOURCE
63122	CABLE: GROUND #12
63004-2	STEPDOWN TRANSFORMER HARNESS – 3 PHASE LINE
63004-1	STEPDOWN TRANSFORMER HARNESS – 120V/24V LINE
63215-2	HARNESS: SENSOR (Blue)
63218-2	A/F VALVE HARNESS (Green)
63220	HARNESS: I/O, 40 PIN RIBBON CABLE
63221	HARNESS: I/O, 30 PIN RIBBON CABLE
63226	HARNESS: OVERTEMP
63227	HARNESS: OPERATING LIMIT
63229-2	HARNESS: THERMOCOUPLE
63231	HARNESS: CONTROL POWER
63232	HARNESS: I/O BOARD 12 VDC POWER
63233	HARNESS: PLUG
65220	IGNITION CABLE

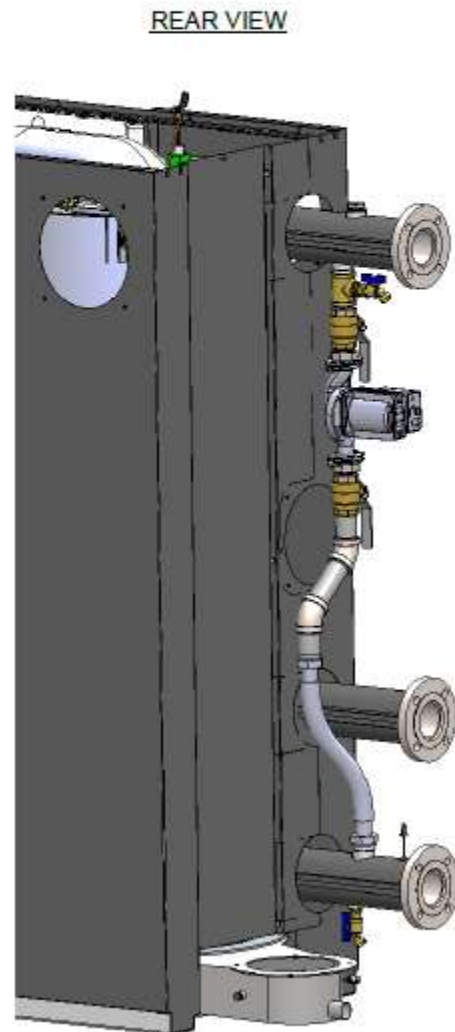
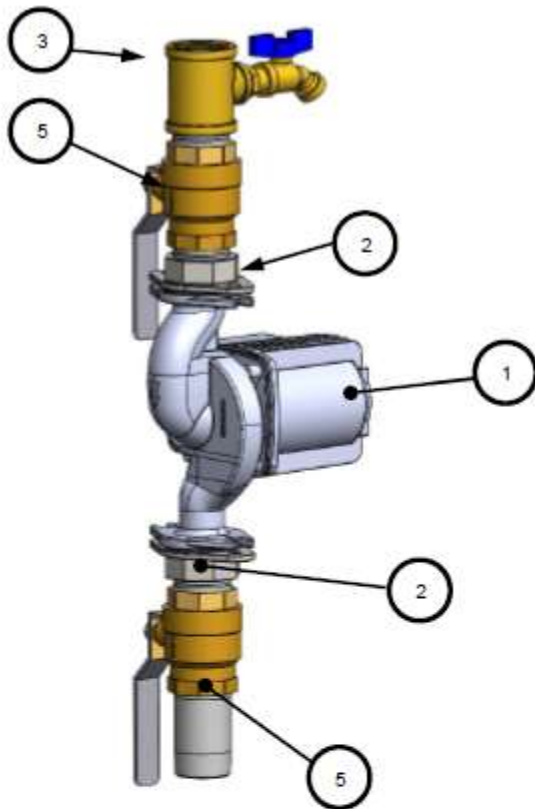
OTHER ACCESSORIES / KITS	
92084-6	MOTORIZED SEQUENCING VALVE (Optional, not shown)
27086-1	ACTUATOR: SSOV w/o P.O.C. SWITCH – FRU Kit
64048	SSOV WITH PRESSURE REGULATOR – FRU Kit
24667-12	A/F Valve, CEN 2000 – FRU Kit

Centurion 2000 Standard Gas Train – NATURAL GAS P/N 22362C							
Item	Qty	Part #	Description	Item	Qty	Part #	Description
1	1	123542	Flange 2" 125# 2" NPT	20	1	60032	Gas Pressure Switch, 1-20 W.C. manual reset
8	1	92006-7	Valve, Ball Brass 1-1/2 NPT"	21	3	9-22	Pipe Plug, 1/4 NPT
11	1	124150	Valve, SSOV 1-1/2 NPT"	22	1	60020	Gas Pressure Switch, 2-20 W.C. auto reset
14	1	69005	Actuator, SSOV W/ Regulator	23	1	99017	Pressure Snubber, 1/4"
15	1	97087-12	Flexible Gas Tube	24	2	92077	1/4" NPT MXF Brass Ball Valve
16	2	12951-2	Bushing, Control Box	25	1	92076	1/4" NPT Ball Valve
19	1	99015	Damping Orifice, SSOV	28	1	93646	Cap, 1" NPT
22	1	60020	Gas Pressure Switch, 2-20 WC	32	1	93707	2 X 1-1/2" NPT Pipe Reducer

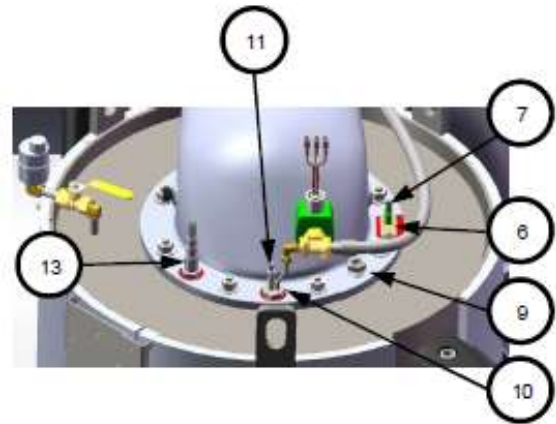
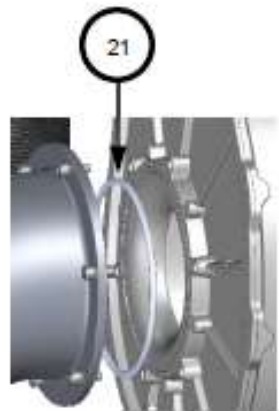
① Replacement Kit and/or Catalog number



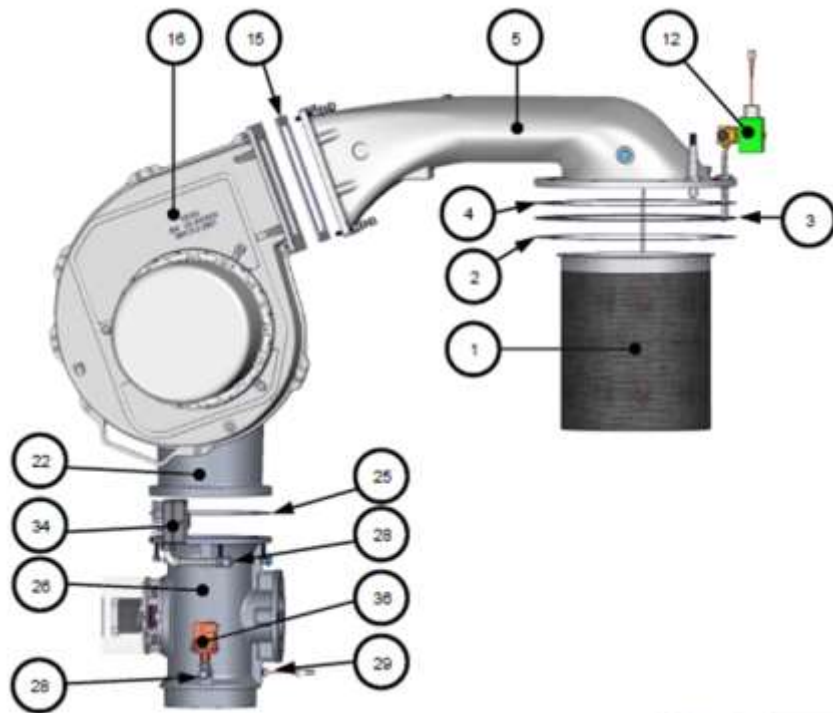
Centurion 2000 Recirculation Loop P/N 22384C			
Item	Qty	Part #	Description
1	1	69371	Circulator Pump
2	2	95037	Flange, Taco
3	1	97174	Reducing Tee, 1½" to ¾" NPT
4	1	92060	¾" Drain Valve
5	2	92125-1.5	Ball Valve, Full Port 1.5" NPT



Centurion 2000 Burner Assembly P/N 26024C			
Item	Qty	Part #	Description
1	1	46063	Burner
2	1	81185	Burner Release Gasket: Lower
3	1	81180	Burner Gasket
4	1	81173	Release Gasket
5	1	43091	Blower Plenum
6	1	81048	Gasket: Flame Rod Low NO _x
7	1	24356-1 ❶	Flame Detector
9	1	59104	Observation Port
10	3	53033	Washer: Clocking
11	1	58023 ❶	Ignitor-Injector
12	1	24277	Staged Ignition Assembly
13	1	61026	O ₂ Sensor
14	3	9-22	Plug: HEX HD 1/4" NPT
15	1	81157	Blower Gasket
16	1	24350	Blower: EBM 3 Phase, 460 VAC
16	1	24351	Blower: EBM 3 Phase, 208 VAC
21	1	81105	O Ring
22	1	43090	Air/Fuel Valve Plenum
25	1	81057	Gasket: Blower
26	1	21006-8	Air/Fuel Valve Assy
28	4	9-21	Plug, 1/8 NTP
29	1	61051	Immersed Temp Sensor, PT-1000
30	1	93230	Snubber
34	1	60011-6	Blower Proof Switch
36	1	61002-5	Blocked Inlet Switch -4.5" W.C.



❶ Replacement Kit and/or Catalog number





APPENDIX D – TEMPERATURE SENSOR RESISTANCE/VOLTAGE

Centurion units have PT-1000 temperature sensors by default. However, users are allowed to change to the older, Balco sensors.

PT-1000 Temperature Sensor Resistance Chart			
Temperature		Sensor Resistance (Ohms)	
°F	°C	PT-1000	Balco
-40	-40.0	843	779
-30	-34.4	865	797.5
-20	-28.9	887	816.3
-10	-23.3	908	835.4
0	-17.8	930	854.8
10	-12.2	952	874.6
20	-6.7	974	894.7
30	-1.1	996	915.1
40	4.4	1000	935.9
50	10.0	1017	956.9
60	15.6	1039	978.3
70	21.1	1061	1000
80	26.7	1082	1022
90	32.2	1104	1044.4
100	37.8	1125	1067
110	43.3	1147	1090
120	48.9	1168	1113.3
130	54.4	1190	1137
140	60.0	1211	1160.9
150	65.6	1232	1185.2
160	71.1	1254	1209.5
170	76.7	1275	1234.7
180	82.2	1296	1260
190	87.8	1317	1285.6
200	93.3	1339	1311.4
210	98.9	1360	1337.7
212	100.0	1381	
220	104.4	1385	1364.2
230	110.0	1402	1391
240	115.6	1423	1418.2
250	121.1	1444	1445.7

