Service Handbook

COMMERCIAL GAS FIRED BOILER

500 Tennessee Waltz Parkway
Ashland City, TN 37015

FOR MODELS:
VW/VB 1500, VW/VB 2000
HOT WATER SUPPLY
HYDRONIC HEATING
SERIES 100, 101

INSTALLATION CONSIDERATIONS - PRE SERVICE CHECKS - WATER HEATER CONSTRUCTION - OPERATION & SERVICE - TROUBLESHOOTING

This model is *i*COMM COMPATIBLE.
iCOMM
For info call:
1-888-WATER02

SERVICING SHOULD ONLY BE PERFORMED BY A QUALIFIED SERVICE AGENT

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INTRODUCTION

This Service Manual covers VF Boiler models VW/VB 1500 and VW/VB 2000 - Series 100/101 Boilers. The instructions and illustrations contained in this Service Manual will provide you with troubleshooting procedures to diagnose and repair common service problems and verify proper operation.

MODEL NUMBERS AND FACTORY CONFIGURATIONS

See the rating plate affixed to the Boiler for Model, Series and Serial numbers. The VF product name stands for Variable Fire. The VF Boiler model numbers are expressed on the boiler rating plates as: VW 1500, VW 2000, VB 1500, and VB 2000. The 1500 models are rated at 1,500,000 Btu/hr and the 2000 models are rated at 2,000,000 Btu/hr. The two different model number prefixes, VW and VB, are used to indicate the factory configurations as follows:

- VW model Boilers are factory configured for domestic hot water system requirements.
- VB model Boilers are factory configured for hydronic heating system requirements.

VW and VB factory configurations differ in three respects:

1. Factory installed all bronze Boiler Circulation Pump:
   - VW Models standard.
   - VB Models optional.
2. Factory installed pressure only relief valve:
   - VW Models 125 PSI valve standard.
   - VB Models 50 PSI valve standard.
3. Temperature Setting Range:
   - VW Models
     - Operating Setpoint: 105°F to 190°F (41°C to 88°C).
     - Automatic Reset High Limit: 135°F to 210°F (57°C to 99°C).
   - VB Models
     - Operating Setpoint: 105°F to 215°F ((41°C to 102°C).
     - Automatic Reset High Limit: 135°F to 235°F (57°C to 113°C).

Note: VW models can be special ordered without the factory installed pump and VB models can be special ordered with a factory installed pump. These factory configurations can also be changed in the field by installing circulation pumps, changing pressure relief valves and dip switch settings on Control System circuit boards to accommodate domestic and hydronic hot water system requirements, see MCB - Section D on page 23 and Field Supplied Boiler Circulation Pumps on page 30.

QUALIFICATIONS

QUALIFIED INSTALLER OR SERVICE AGENCY

Service of VF Boilers requires ability equivalent to that of a Qualified Service Agent (defined by ANSI below) in the field involved. Installation skills such as plumbing, air supply, venting, gas supply and electrical supply are required in addition to electrical testing skills. Start up and servicing of VF Boilers also requires combustion analysis skills and test equipment.

ANSI Z223.1 2006 Sec. 3.3.83: “Qualified Agency” - “Any individual, firm, corporation or company that either in person or through a representative is engaged in and is responsible for (a) the installation, testing or replacement of gas piping or (b) the connection, installation, testing, repair or servicing of appliances and equipment; that is experienced in such work; that is familiar with all precautions required; and that has complied with all the requirements of the authority having jurisdiction.”

SERVICE WARNING

If you are not qualified (as defined by ANSI above) and licensed or certified as required by the authority having jurisdiction to perform a given task do not attempt to perform any of the procedures described in this manual. If you do not understand the instructions given in this manual do not attempt to perform any procedures outlined in this manual.

SERVICE REMINDER

When performing any troubleshooting step outlined in this Service Manual, always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to and from a given component before replacing components. Ensure wires were stripped before being crimped in a wire connector, ensure wires are crimped tightly in their connectors, ensure connection pins in sockets and plugs are not damaged or worn, ensure plugs and sockets are mating properly and providing good contact.

Failure to perform this critical step or failing to perform this step thoroughly often results in needless down time, unnecessary parts replacement, and customer dissatisfaction.

TOOLS REQUIRED

- Instruction Manual that came with the Boiler.
- Hand tools common to installation and service of commercial water heaters and boilers.
- TORX® T40 or 5 mm hex wrench - for setting gas mixture at gas valve.
- 3 mm or 7/64 inch hex (Allen) wrench - for setting gas mixture at gas valve.
- Two Manometers or Pressure Gauges
  - One - U tube manometer or gauge for measuring supply gas pressure.
  - One (optionally two) digital Manometer(s) range -15.00 to +15.00" W.C., resolution 0.01" W.C. Recommend UEI model EM200, TPI model 620 or equivalent. Used to measure manifold gas pressures and to test performance of pressure switches. Optional second digital manometer can be used in place of U tube manometer for measuring supply gas pressures.
- 1/4" and 3/8" plastic/silicone/rubber flexible tubing - used to connect manometers to pressure sensing ports on Boiler during start up and service.
- 1/4" and 3/8" plastic barbed Tee fitting - standard automotive emission grade fittings - used to connect manometers to pressure sensing ports on Boiler during start up and service.
- True RMS Digital Multi Meter DMM, recommend UEI model DL289 or Fluke equivalent. Capable of measuring:
  - AC/DC Voltage
  - Ohms
  - DC micro amps μA (flame sensing current)
- AC amp meter- recommend UEI model DL289 or equivalent.
- Combustion analyzer capable of measuring:
  - CO2 (carbon dioxide)
  - CO (carbon monoxide)
  - Draft Pressure
  - Exhaust Temperature (vent gases)

INSTALLATION CONSIDERATIONS

This section of the Service Manual covers some of the critical installation requirements that, when overlooked, often result in operational problems, down time and needless parts replacement. Costs to correct installation errors are not covered under the limited warranty. Ensure all installation requirements and instructions contained in the Instruction Manual that came with the Boiler have been followed prior to performing any service procedures.

INSTRUCTION MANUAL

Have a copy of the Instruction Manual that came with the Boiler on hand for the Model and Series number being serviced. Installation information given in this Service Manual is not a complete installation instruction. Installation information given in this manual has a limited focus as it applies to servicing the Boiler. This Service Manual does not replace or supersede the Instruction Manual that came with the Boiler. Always refer to the Instruction Manual for complete installation instructions. If the Instruction Manual is not on hand, copies can be obtained from the manufacturers web site or by calling the toll free support phone number shown on the back cover of this manual.

CLOSED WATER SYSTEMS

Water supply systems may, because of code requirements or such conditions as high line pressure, among others, have installed devices such as pressure reducing valves, check valves, and back flow preventers. Devices such as these cause the water system to be a closed system.

THERMAL EXPANSION

As water is heated, it expands (thermal expansion). In a closed system the volume of water will grow when it is heated. As the volume of water grows there will be a corresponding increase in water pressure due to thermal expansion. Thermal expansion can cause premature tank failure (leakage). This type of failure is not covered under the limited warranty. Thermal expansion can also cause intermittent Temperature-Pressure Relief Valve operation; water discharged from the valve due to excessive pressure build up. This condition is not covered under the limited warranty. The Temperature-Pressure Relief Valve is not intended for the constant relief of thermal expansion.

A properly sized thermal expansion tank must be installed on all closed systems to control the harmful effects of thermal expansion. Contact a local plumbing service agency to have a thermal expansion tank installed.

AIR REQUIREMENTS

Carefully review the requirements for combustion and ventilation air in the Instruction Manual that came with the Boiler. Failure to meet these requirements when the Boiler is installed or overlooking their importance when servicing the Boiler often results in needless down time, unnecessary parts replacement, and customer dissatisfaction.

An inadequate supply of air for combustion and ventilation often causes operational problems. A lack of combustion and ventilation air can create a negative ambient air pressure in the installed space which can lead to improper combustion and operational problems with pressure switches.

CONTAMINATED AIR

Combustion air that is contaminated can greatly diminish the life span of the Boiler and its components such as Igniters and Burners. Propellants of aerosol sprays, beauty shop supplies, water softener chemicals and chemicals used in dry cleaning processes that are present in the combustion, ventilation or ambient air can cause such damage.

Vapors from volatile compounds such as solvents, cleaners, chlorine based chemicals and refrigerants in addition to being highly flammable in many cases, can also react to form highly corrosive substances such as hydrochloric acid inside the combustion chamber. The results can be hazardous and cause product failure.

If the Boiler is installed in laundries with dry cleaning equipment, it is imperative the Boiler be installed in a Direct Vent configuration so that air for combustion is derived directly from the outdoor atmosphere through a sealed intake air pipe. See the venting installation section in the Instruction Manual that came with the Boiler for more information on Direct Vent installations.

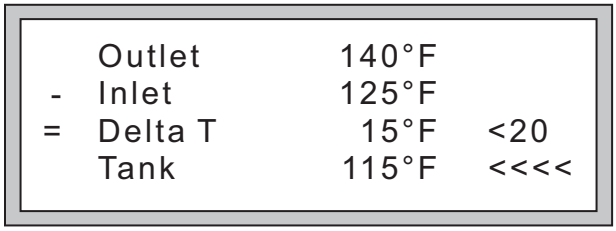
VENTING

Ensure all venting requirements and venting installation instructions contained in the Instruction Manual that came with the Boiler have been observed and followed. Failing to install the required Boot Tee fitting at the Boiler's vent connection, not installing the factory provided vent and/or intake air terminations, exceeding the maximum equivalent vent and/or intake air piping lengths, adding too many elbows to the intake air and/or vent pipes, installing the wrong vent/intake air pipe size, will cause operational problems, improper combustion, rough starting/operation and Control System lock outs.

WATER PIPING

Ensure all water piping requirements, diagrams and piping installation instructions contained in the Instruction Manual that came with the Boiler have been observed and followed. Factory installed pumps on VF Boilers are sized for up to a maximum of 25 equivalent feet of outlet (supply) and inlet (return) piping; 50 equivalent feet total. Exceeding these limitations will lead to Control System lock outs and can permanently damage the Boiler's Heat Exchanger. A bypass line must be installed between the outlet and inlet piping of the Boiler on the "system side" of the Boiler's Circulation Pump to prevent condensation on the copper Heat Exchanger, see the Piping Diagrams beginning on page 65.

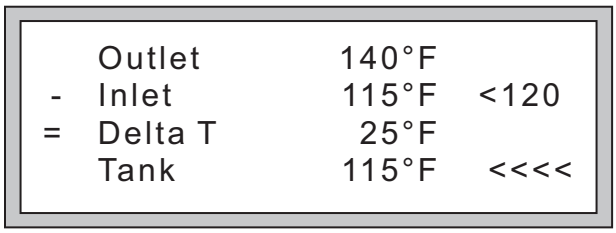
TEMPERATURE RISE & FLOW RATE



Water flow rates through the Boiler are critical, flow rates that are too low may cause excessive lime/calcium accumulation inside the Heat Exchanger while flow rates that are too high can lead to velocity erosion that can eventually cause water leaks. Boiler efficiency is also affected by flow rates. Measuring the actual water flow rate (gallons per minute) through the Boiler is often impractical in the field. Because the temperature rise through the Boiler is directly linked to the flow rate and is simple to measure, temperature rise is commonly used to confirm proper flow rates.

Temperature rise is calculated by subtracting the inlet water temperature from the outlet water temperature. Temperature rise is commonly referred to as the "Delta T" and expressed as ΔT. The temperature rise through the Boiler should be set between 20° F and 30°F. Temperature rise (flow rate) is set by throttling a flow control valve installed in the Boiler's outlet (supply) water line with the boiler firing at 100%, see Figure 33 on page 65. Never attempt to throttle the outlet valve unless the Boiler is firing at 100%. Valves on the Boiler's inlet (return) water line must never be throttled and left fully open at all times except when servicing the Boiler. The Outlet, Inlet and Delta T (ΔT) are all displayed on the Control System's default Temperatures Menu. The Control System is programmed to warn the end user whenever the temperature rise is below 20° F by slowly flashing on and off "< 20" to the right of Delta T on the default Temperatures Menu. See the illustration above.

BYPASS LINES



Bypass lines are required on all VF Boiler installations to maintain a minimum inlet water temperature of 120°F. Bypass lines feed a portion of the outlet water back to the inlet of the Boiler which raises the inlet water temperature and helps prevent condensate formation on the copper Heat Exchanger, see Figure 3 on page 9. Bypass lines are installed with a flow control valve between the Boiler's outlet (supply) and inlet (return) water lines, see Figure 33 on page 65. After the temperature rise through the Boiler has been set the flow control valve in the bypass line is throttled to ensure a minimum 120° F inlet water temperature with the Boiler firing at 100%. Never attempt to throttle the bypass valve unless the Boiler is firing at 100%.

Some condensate formation on a cold start up is normal. However, if condensate formation is not prevented during normal operating conditions, copper oxide will form on the Heat Exchanger and will eventually block the flow of flue gases through the Heat Exchanger. The Control System is programmed to warn the end user whenever the inlet water temperature is below 120° F by slowly flashing on and off "< 120" to the right of Inlet water temperature on the default Temperatures Menu. See the illustration above.

BOILER CONTROLS

Boiler controls that are improperly installed or configured can cause serious operational and service related problems such as short cycling. This section provides information for how various controls can work together or independently to provide proper boiler and system control.

THE HEATING CYCLE

Two conditions must be met before the VF Boiler can start a heating cycle:

1. The actual temperature sensed by the Control System from the designated "Controlling Probe" (page 7) must be lower than the Operating Setpoint minus the Setpoint Differential, see Adjusting User Settings on page 43.
2. The Enable/Disable circuit must be a closed circuit. There are two wires provided in the wiring junction box on the back of the Boiler for this circuit, see Figure 1.

NOTE: See the Sequence Of Operation on page 45.

PRIMARY SYSTEM CONTROL

All VF Boiler installations require a “Primary System Control” that senses and reacts to water temperature inside the storage tank on domestic water applications or in the return line on primary/secondary hydronic heating systems. When installed and configured properly the Primary System Control will activate and deactivate boiler heating cycles based on its setpoint compared to current system water temperature. There are three suitable methods to configure a Primary System Control. One of the following three methods **MUST BE** used.

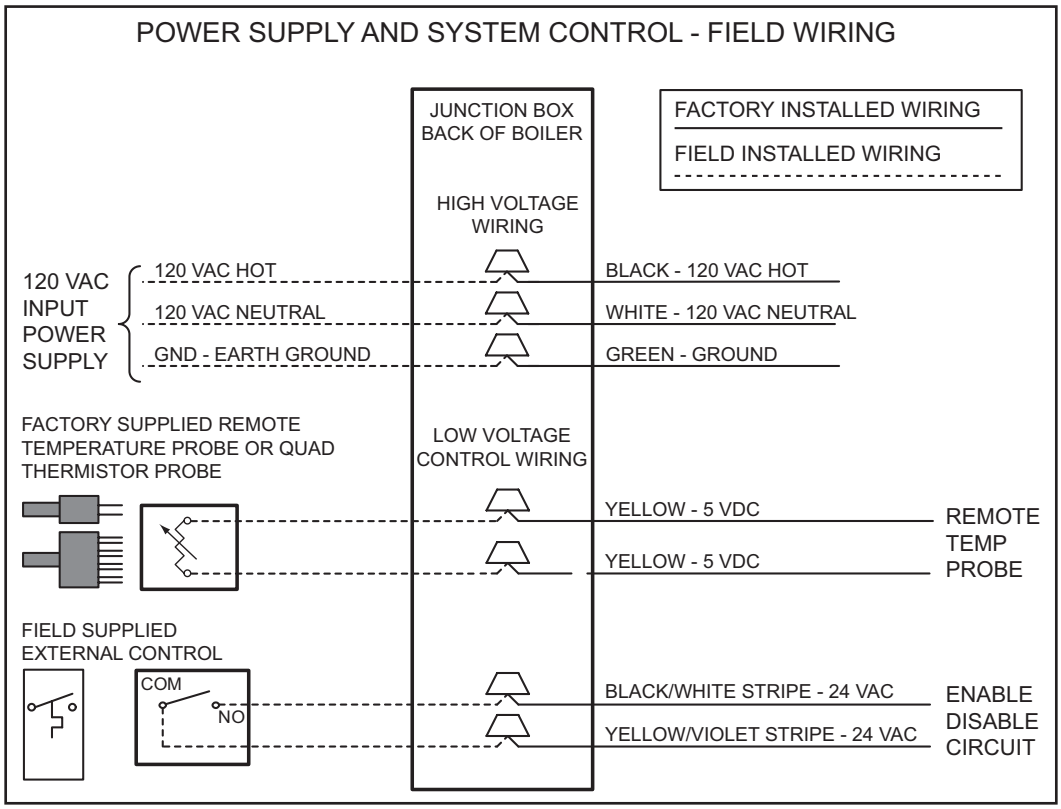


Figure 1

1. The Primary System Control can be the Boiler’s EMC 5000 Control System working with the factory supplied Remote Temperature Probe or the optional Quad Thermistor Probe installed inside the storage tank on domestic water applications or in the return line on primary/secondary hydronic heating systems. This application ensures the Boiler’s ability to fully modulate its firing rate. See Temperature Probes on page 15 and Figure 33 on page 65.
2. Alternatively, the iCOMM™ system hardware working with an onsite BACnet compliant BMS (Building Management System) can be used as a Primary System Control. This application ensures the Boiler’s ability to fully modulate its firing rate and allows BACnet compliant controls to utilize outdoor temperature

reset schedules to maximize energy savings on hydronic heating applications during medium and low load conditions. The onsite BACnet compliant BMS must have its own temperature sensor installed in the storage tank for domestic water applications or in the return line on primary/secondary hydronic heating systems or it must monitor the factory supplied Remote Temperature Probe or Quad Thermistor Probe as described in the first method to initiate boiler heating cycles. iCOMM™ system hardware is purchased separately from the manufacturer. For more information call 888 928-3702.

3. The Primary System Control may also be a field supplied external control such as a storage tank thermostat or boiler sequencing panel. Field supplied external controls must meet three requirements to be a suitable Primary System Control:
   A. The field supplied control must be able to sense water temperature inside the storage tank on domestic water applications or in the return loop on primary/secondary hydronic heating systems.
   B. The field supplied control must function as a thermostat with a set of “dry” (no voltage or load) control contacts to use with the Boiler’s Enable/Disable circuit, see Figure 1 on page 6 for wiring.
   C. The field supplied control must open/close its control contacts based on actual system temperature AND its own system temperature setpoint.

   FIELD SUPPLIED CONTROL NOTES: If the field supplied external control does not meet all three of the requirements listed above it **MUST NOT** be used as the required Primary System Control.

   When using a field supplied external control as the Primary System Control the Operating Setpoint of Boiler Control System must be set at least 5° higher than the system setpoint of the field supplied control. This is done to ensure the Boiler’s setpoint does not deactivate the current heating cycle before the external control’s setting has been satisfied. This also prevents the Boiler from short cycling. See Adjusting User Settings on page 43.

   When a field supplied external control is used as the Primary System Control it activates and deactivates boiler operation based on the temperature it senses in the system. It cannot control the Boiler’s firing rate. **The Boiler is not able to modulate its firing rate when using this type of Primary System Control.**

REMOTE TEMPERATURE PROBE INSTALLATION

All VF Boilers are supplied from the factory with a Remote Temperature Probe which is suitable for all single boiler applications, see Figure 8 on page 15. When connecting up to 4 boilers to a single storage tank or one primary/secondary hydronic heating system the optional Quad Thermistor Probe should be used, see Figure 9 on page 16. Call the toll free parts department phone number on the back of this manual to order the Quad Thermistor Probe.

On domestic hot water applications the Remote Temperature Probe or the optional Quad Thermistor Probe **MUST BE** installed in the designated temperature control opening on the storage tank, typically a 3/4 inch NPT opening in the lower portion of the tank. On hydronic heating applications the probe being used **MUST BE** installed in the return line of the primary hydronic heating loop before (upstream) the first boiler. A field supplied Tee fitting with a 3/4 inch NPT branch is installed in the return line for this purpose. See Figure 33 on page 65 and the piping diagrams in the back of this manual for probe location.

Once the probe has been installed in the system, see the Field Wiring section in the Installation Manual that came with the Boiler and Figure 1 on page 6 in this manual for wiring instructions.

THE CONTROLLING PROBE

When the Remote Temperature Probe or the optional Quad Thermistor Probe and the field wiring has been installed the probe being used must be designated as the “Controlling Probe." To do this turn off power to the Boiler and locate the SW1 dipswitch array on the MCB circuit board, see Figure 12 on page 19 and Figure 16 on page 23.

SW1 dipswitch #4 must be set to the “On” position to configure the Remote Temperature Probe or the optional Quad Thermistor Probe as the Controlling Probe. The SW1 dipswitch #4 is set to “Off” from the factory so this change must be performed on all installations. When power to the Boiler is turned back on the Boiler’s Control System will now monitor the remote probe that was installed and use temperature data from that probe to activate and deactivate heating cycles and to modulate the firing rate of the Boiler. See Table 4 on page 23 to configure the SW1 dipswitches.

FEATURES AND COMPONENTS

FRONT, BACK & SIDE VIEWS

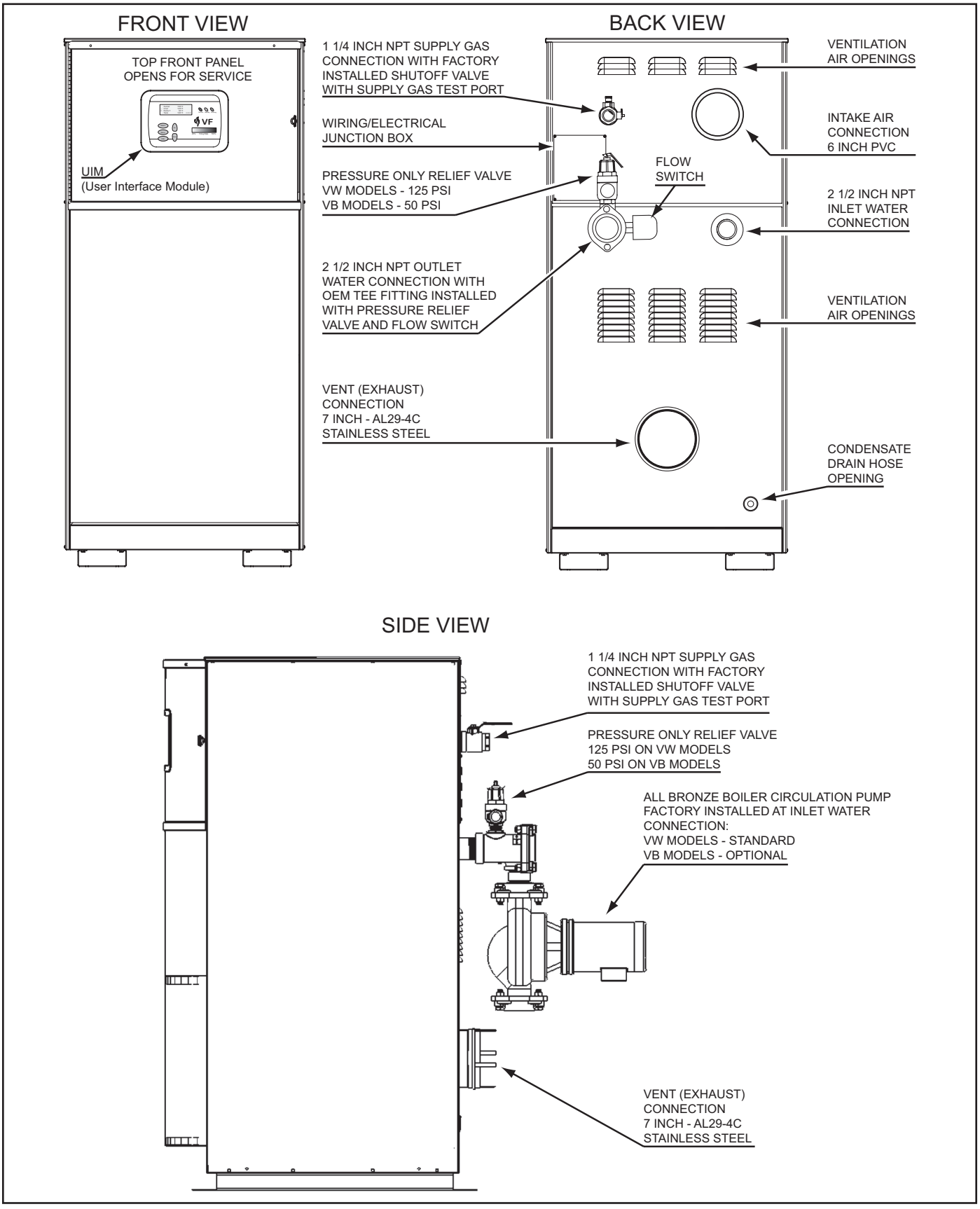


Figure 2

HOW IT WORKS

VF Boiler Heat Exchangers are ASME constructed and rated at 160 PSI. All VF Boilers are SCAQMD Rule 1146.2 low NOx compliant and are equipped with CSD-1 compliant controls. The Heat Exchanger is a circular shaped vertical tube 4 pass Heat Exchanger constructed from 30 extruded copper tubes roll fitted into two ASME grade steel multiple pass headers that are glass lined.

Water enters the upper header through the inlet water connection and travels down and up a total of 4 times through the copper tubes and headers. Steel vertical flue baffles are secured to the copper tubes to regulate the flow of flue gases.

The Heat Exchanger is housed in a sealed stainless steel combustion chamber to contain the products of combustion and properly convey flue gases to the vent/exhaust connection on the back of the boiler. This combustion chamber design prevents critical boiler components from being exposed to high temperature flue gases. The boiler cabinet is constructed with multiple panels that can be removed during operation for inspection.

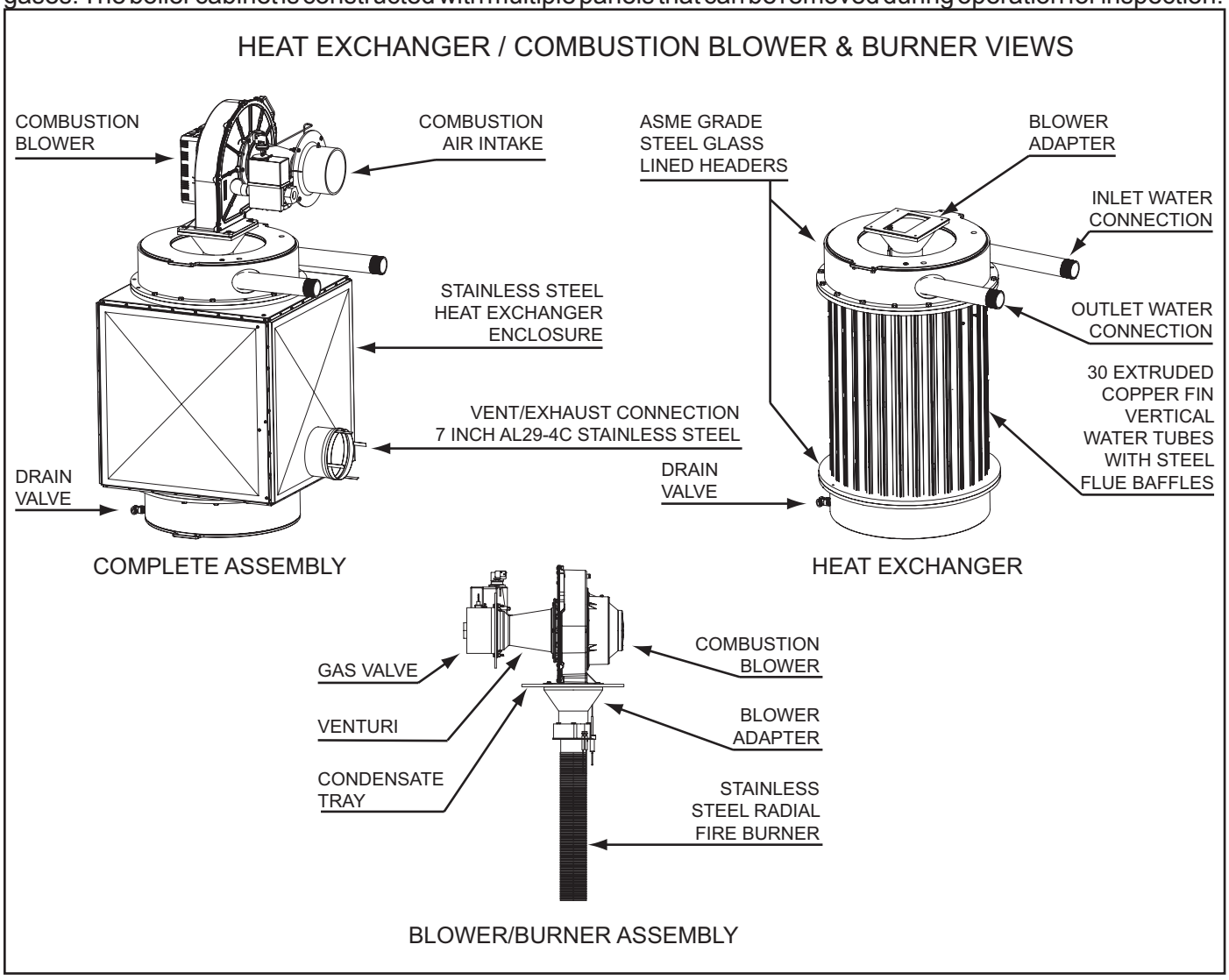


Figure 3

MODULATING FIRE OPERATION

VF Boilers are modulating fire boilers, the Control Systems modulates the firing rate of the Burner between 25% and 100% to match system load by controlling the speed of the Combustion Bower, see Figure 4.

VF Boilers do not have a gas orifice. The Combustion Blower "pulls" fuel gas from the outlet of the 120 VAC Gas Valve (when energized) into a Venturi that is connected to the inlet of the Combustion Blower, see Figure 6 on page 12. The firing rate of the Boiler is directly proportional to the speed of the Combustion Blower motor. As the blower speed increases, the pressure inside the Venturi falls creating a stronger vacuum which pulls more fuel gas into the blower/burner assembly which increases the firing rate.

The Control System controls the speed of the Combustion Blower in response to system temperature. As the system temperature falls blower speed is increased to provide more heating capacity. The Control System sends digital speed instructions to the electronic speed control which is part of the Combustion Blower assembly, see Figure 4 on page 10.

COMBUSTION BLOWER

The Combustion Blower is an assembly that includes the blower motor, housing and an integral electronic speed control. The PDB (Power Distribution Board - see page 28) sends 120 VAC and an earth ground from its J3 socket to the 120 VAC 3 pin socket on the Combustion Blower assembly to power the electronic speed control. The MCB (Modulation Control Board - see Figure 12 on page 19) sends an instruction to start, stop and control the blower motor speed. Four wires from the J24 socket on the MCB (see page 27) carry this instruction to the 5 pin socket on the Combustion Blower assembly, see Figure 4 below.

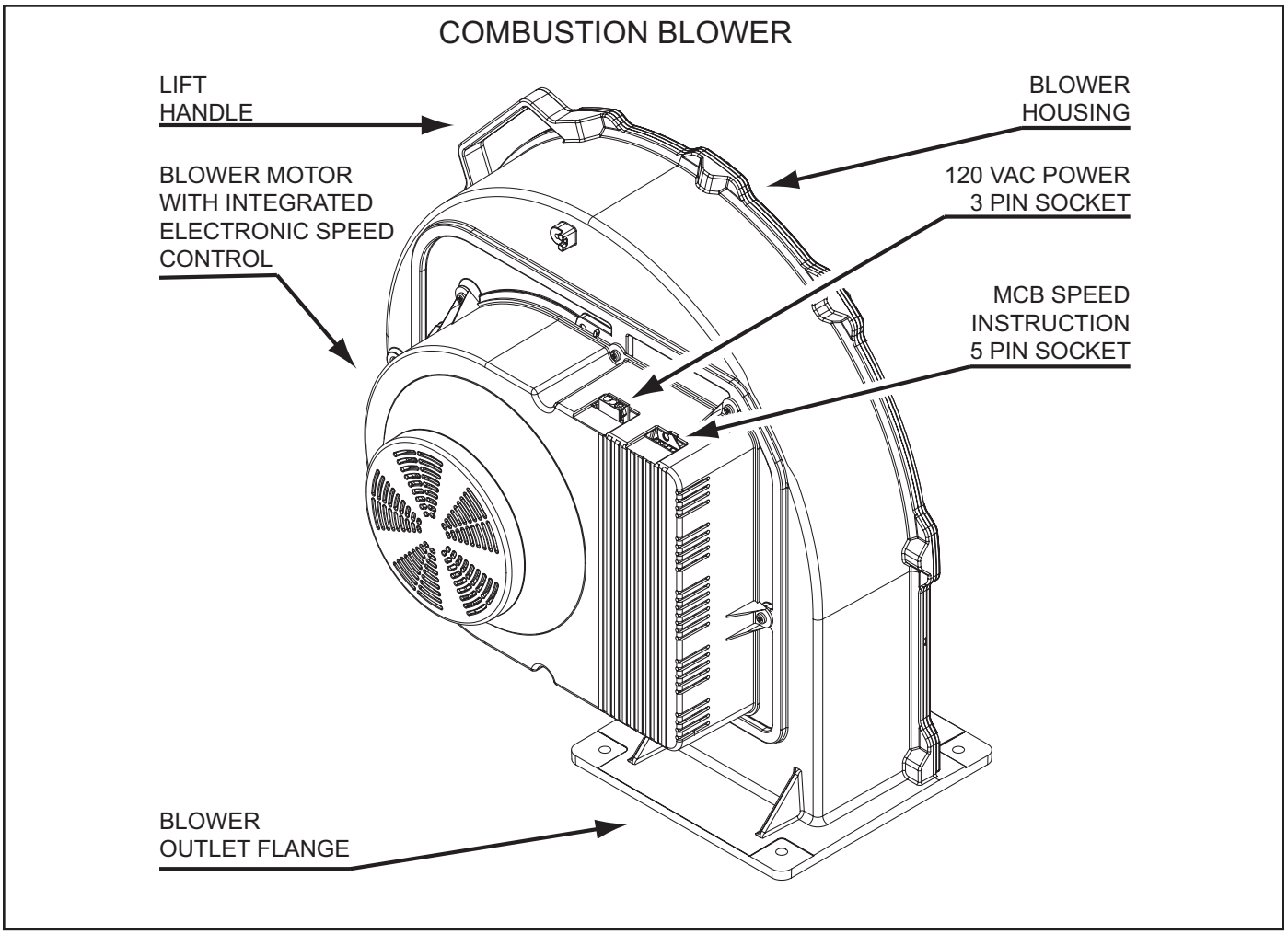


Figure 4

BURNER ASSEMBLY

The Burner on the VF Boiler is a stainless steel radial fire burner with a woven steel fiber surface. It is installed in the center of the vertical tube Heat Exchanger, see Figure 3 on page 9. The Burner is mounted inside the recess of the top header on the Heat Exchanger. A Blower Adapter is installed between the Combustion Blower's condensate tray and the Burner, see Figure 5 below.

The Igniter on the VF Boiler is a 120 VAC hot surface igniter. The Igniter receives power from the J18 socket on the MCB (Modulation Control Board - see page 22). Normal resistance of the Igniter is 40-70 ohms @ 77° F (25° C). The Control System monitors current through the Igniter and must sense a minimum of 2.7 AC amps before it will energize the 120 VAC Gas Valve.

A Low Gas Pressure Switch is installed in the body of the 120 VAC Gas Valve. This is a normally open switch that closes on a rise in pressure. Switch contacts close at +4.0" W.C. on natural gas models and +6.4" W.C. on propane gas models.

VF Boilers have two Flame Sensors. One Flame Sensor is mounted close to the Burner to sense flame at lower firing rates; the second Flame Sensor is mounted further away to sense flame at higher firing rates, see Figure 5 below. A single wire, connected the J16 spade connector (see page 22) on the MCB, is bifurcated (divided) into two wires, each end then connects to one of the two Flame Sensors. The Control System must sense a minimum of 2.5 DC micro amps (2.5 µA) to prove flame at the Burner.

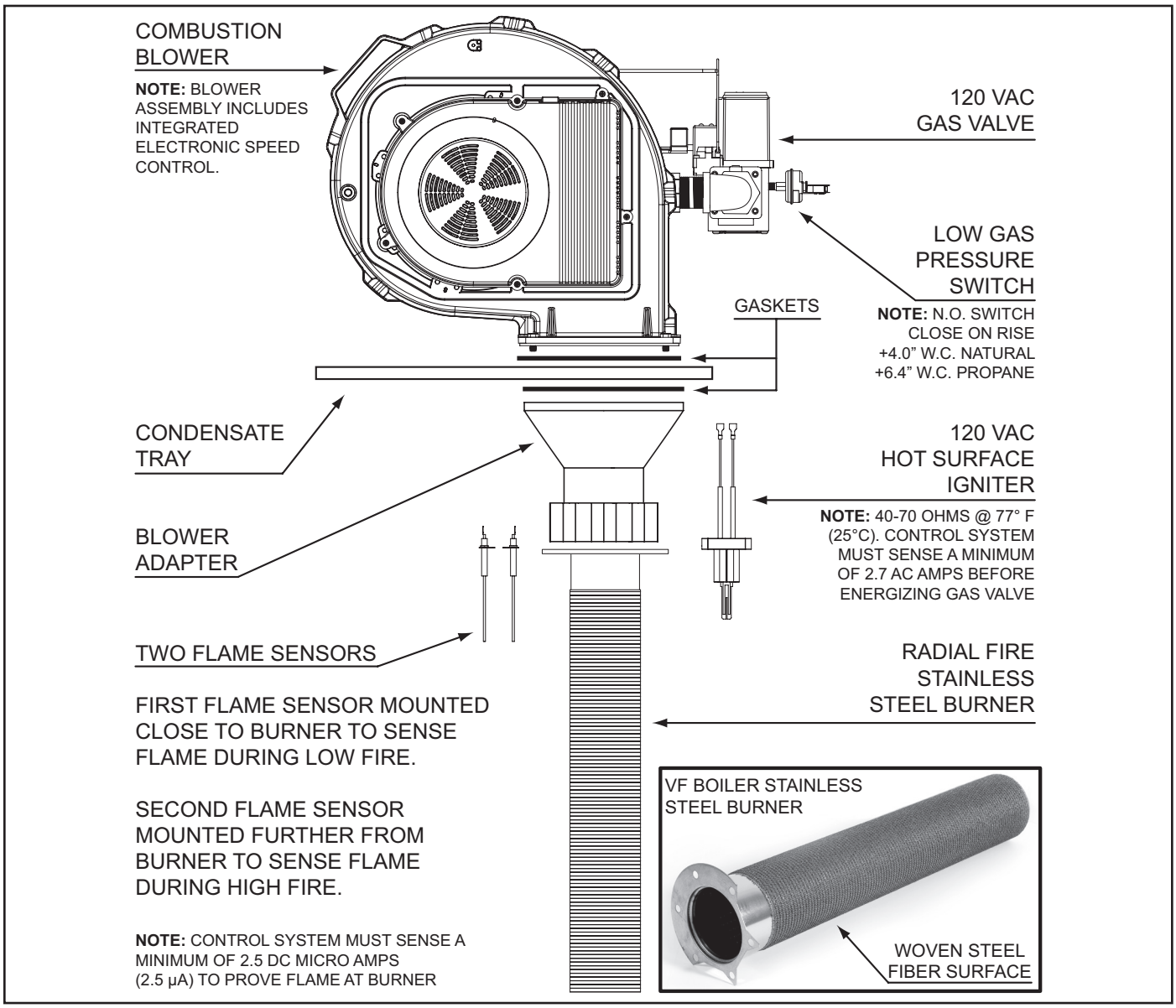


Figure 5

VENTURI & GAS TRAIN

The gas train includes a Venturi connected to the inlet of the Combustion Blower. The outlet of the 120 Volt Gas Valve is also connected to the Venturi by a manifold gas line. There is a shutoff valve installed in the manifold gas line for start up and service procedures. The Venturi contains a convergent/divergent nozzle (cone shaped restrictor) that constricts the air passage to the blower. As air enters the constriction point its velocity increases. A pressure drop occurs at this point and creates a negative (vacuum) pressure in the cavity between the nozzle and the Venturi housing. This negative pressure "pulls" gas from the outlet of the 120 Volt Gas Valve into the blower where it is mixed with combustion air and then supplied to the burner, see Figure 6.

As the Combustion Blower speed is increased (page 10) the velocity of air flowing through the Venturi is also increased. This increases the vacuum created by the Venturi and more fuel gas is pulled from the 120 Volt Gas Valve and supplied to the Burner. This increases the firing rate (input Btu/hr) of the VF Boiler. As the blower speed is decreased less fuel gas is supplied to the Burner and the firing rate is reduced.

The MCB controls blower speed according to system temperature. When system temperature sensed at the Controlling Probe (page 7) is well below the Operating Set Point the MCB will run the blower at maximum speed = 100% firing rate. As system temperature rises closer to the Operating Set Point the MCB will reduce blower speed which reduces (modulates) the firing rate. VF Boilers are designed to modulate between 25% and 100%; a 4 to 1 turn down rate.

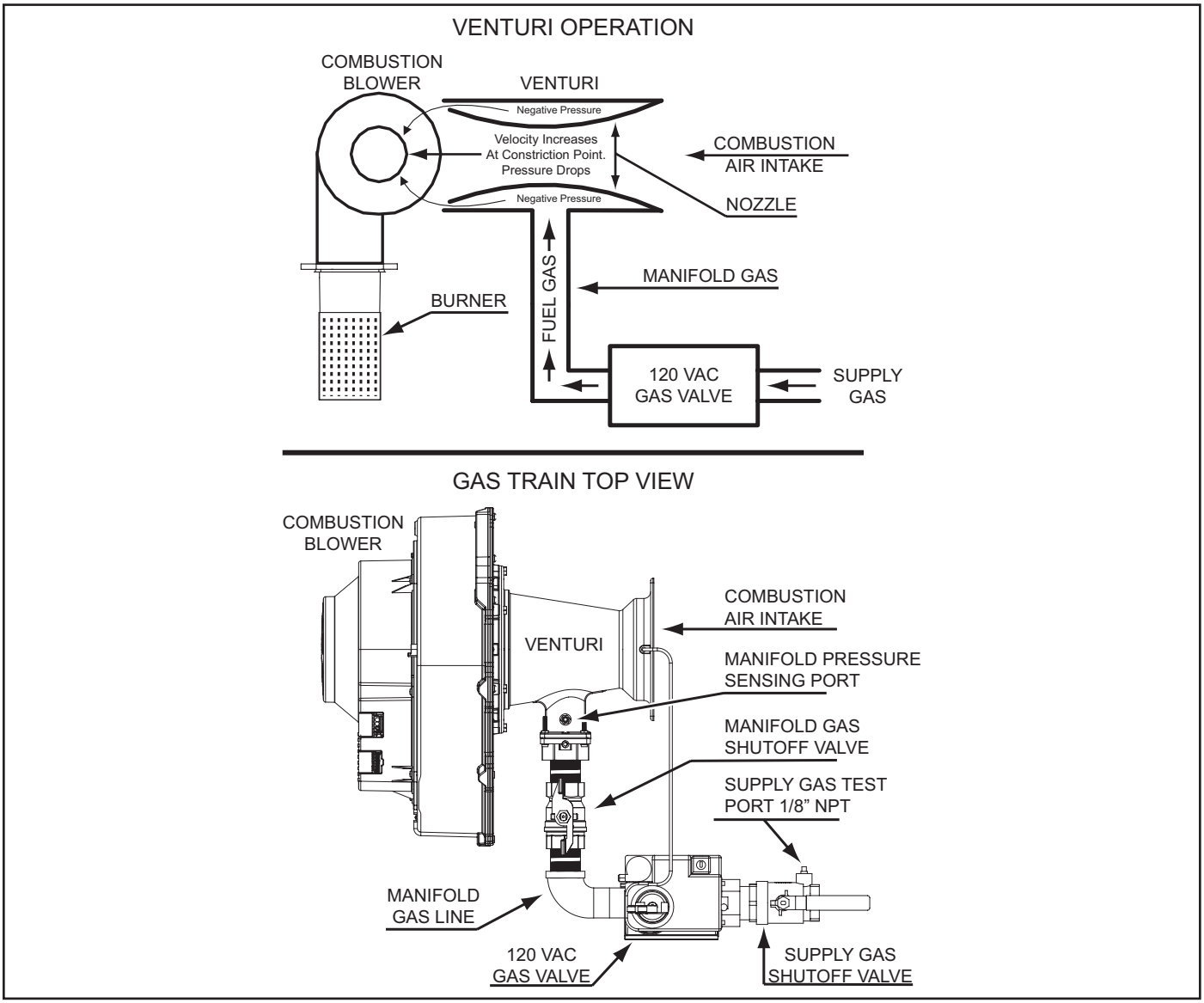


Figure 6

CONFIG KEY

The Config Key is an 18” long cable with a plug on one end and an EEPROM memory chip sealed at the other. The Config Key plugs into the J23 socket on the MCB, see MCB - Section H on page 27. The memory chip contains blower speed programming data specific to the input Btu/hr and fuel type for each VF Boiler. VF Boilers are available in natural and propane gas and in five input Btu/hr models ranging from 500,000 to 2,000,000. This Service Manual covers the 1,500,000 and 2,000,000 Btu/hr models only.

Each time the Boiler is powered up the MCB reads and then stores the blower speed programming data from the Config Key into it’s own internal memory. The MCB then uses the data to modulate the Combustion Blower speed by sending instructions from the MCB J24 socket to the 5 pin socket on the Combustion Blower Assembly, see Figure 4 on page 10 and MCB - Section H on page 27. Modulating the Combustion Blower speed also modulates the firing rate on VF Boilers, see Venturi & Gas Train on page 12.

There is a label at the end of the Config Key cable near the memory chip that identifies which boiler model it is used for. This end of the cable is threaded into the wiring chase during manufacturing. The software revision for the Config Key can be viewed in the Log & System Info menu, see Control System Menus on page 44.

WARNING:

Config Keys are manufactured for a particular fuel type and input Btu/hr rating as described above. Config Keys **MUST NOT** be interchanged in the field for any reason. Doing so can cause ignition failure, rough starting/operation and poor combustion. Changing a Config Key can permanently damage the Boiler, cause property damage, personal injury or death. Damage to the Boiler caused by interchanging Config Keys in the field is not covered under the limited warranty as this would be considered a field alteration of the Boiler's design.

If it is suspected the Config Key is defective or the Boiler is experiencing ignition failure, rough starting/operation and/or poor combustion, ensure the proper Config Key is installed. Navigate to the Log & System Info menu in the control system and record the kBTU Rating, Fuel Type and Config Key Rev number, see Control System Navigation on page 40 and Control System Menus on page 44. If the Fuel Type and/or kBTU rating listed in the Log & System Info menu does not match the rating plate on the Boiler, turn the Boiler off and disable Boiler operation. Call the toll free support phone number on the back cover of this manual for further assistance.

Figure 7

COMBUSTION BLOWER SPEED DATA

Nominal Combustion Blower speeds during various operating states for natural gas models are shown in Table 1 below. Combustion Blower speeds for propane models are shown in Table 2. Due to slip in the Combustion Blower and manufacturing tolerances in the electronic speed control these numbers will vary.

When combustion is poor, the firing rate of the Boiler or the Combustion Blower speed is in question, or the Boiler is experiencing rough starting/operation or ignition failure compare the values given here to actual blower speeds shown in the Control States menu. The current blower speed (RPM) and operating state can be viewed in real time in the Control States menu, see Control System Navigation on page 40 and Control System Menus on page 44.

Viewing the Combustion Blower speed data can also be useful if the Config Key (see page 13) is suspected as being defective. Actual blower speeds will vary somewhat but should be relatively close to what is shown in the tables below. If Combustion Blower speeds vary greatly, 25% or more, or if the Config Key is suspected as being defective call the toll free support phone number on the back cover of this manual for further assistance.

TABLE 1

NATURAL GAS MODELS		
OPERATING STATE	**VW/VB 1500 NOMINAL BLOWER SPEED**	**VW/VB 2000 NOMINAL BLOWER SPEED**
Pre/Post Purge Periods	4950 RPM	4950 RPM
Ignition Trial Period	1800 RPM	1800 RPM
Forced Maximum Firing Rate 100%	3700 RPM	4650 RPM
Forced Minimum Firing Rate 25%	920 RPM	1225 RPM

TABLE 2

PROPANE GAS MODELS		
OPERATING STATE	**VW/VB 1500 NOMINAL BLOWER SPEED**	**VW/VB 2000 NOMINAL BLOWER SPEED**
Pre/Post Purge Periods	4950 RPM	4950 RPM
Ignition Trial Period	1800 RPM	1800 RPM
Forced Maximum Firing Rate 100%	3700 RPM	4415 RPM
Forced Minimum Firing Rate 25%	900 RPM	1170 RPM

TEMPERATURE PROBES

Temperature probes are 3/4 inch male NPT threaded immersion probes, see Figure 8. Temperature probes have embedded temperature sensors (thermistors). Thermistors are thermally sensitive resistors; as the surrounding temperature rises the resistance of the thermistor (measured in ohms) will decrease and as the surrounding temperature falls the resistance of the thermistor increases, see Table 3 on page 16. The Boiler's Control System monitors these sensors to determine water temperature at various points in the system.

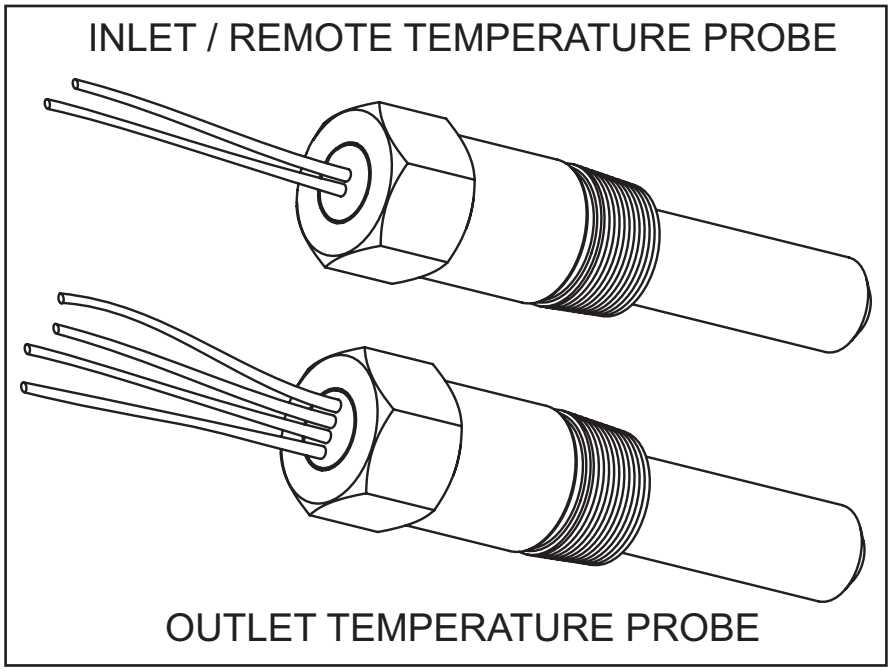


Figure 8

INLET AND OUTLET TEMPERATURE PROBES

All VF Boilers have one Inlet and one Outlet Temperature Probe factory installed in the top of the Heat Exchanger to monitor the water temperature entering and leaving the Boiler. The Inlet Probe is a temperature sensor only and has two wiring leads. The Outlet probe also contains the manual reset high temperature limit switch and has four wiring leads. The Control System displays the Inlet and Outlet water temperatures sensed from these two probes on the default Temperatures Menu. The Control System also displays the temperature difference between the Inlet and Outlet Temperature Probes on the Temperatures Menu as the "Delta T" value. See Figure 29 on page 40.

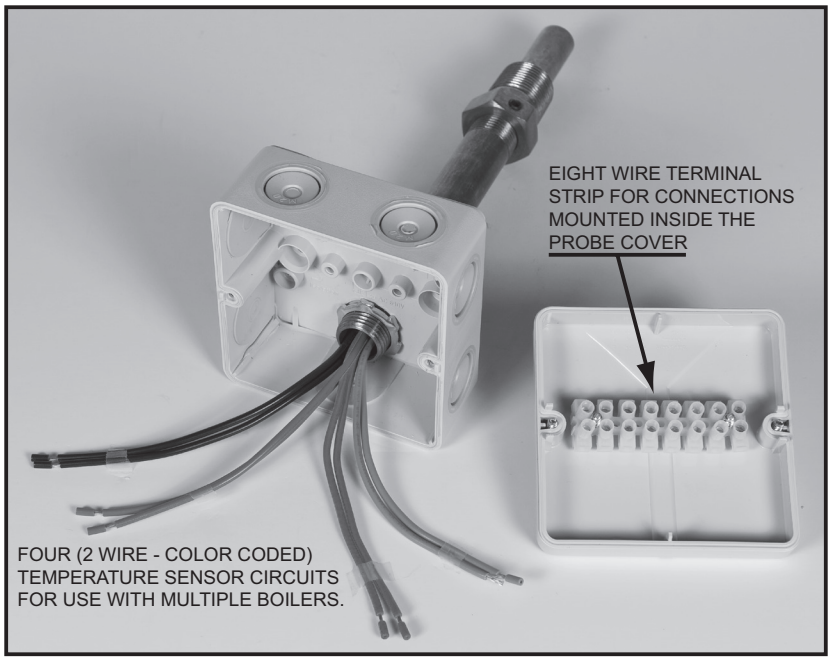
REMOTE TEMPERATURE PROBE

All VF Boilers are supplied from the factory with a Remote Temperature Probe. The supplied Remote Temperature Probe is used to control system water temperature for a single boiler in a domestic hot water storage tank or in the return line from a primary/secondary hydronic heating system. Use of the Remote Temperature Probe allows a boiler to sense the actual water temperature inside the storage tank or hydronic heating loop. The Boiler will modulate its firing rate in response to the actual system temperature and load conditions. The Control System displays the temperature sensed from the Remote Temperature Probe as the "Tank" temperature on the default Temperatures Menu. See Figure 29 on page 40.

QUAD THERMISTOR PROBE

When connecting up to 4 boilers to a single storage tank or one primary/secondary hydronic heating system the optional Quad Thermistor Probe should be used. The Quad Thermistor Probe is a remote temperature probe with four temperature sensors embedded in one device. The Quad Thermistor Probe allows up to 4 boilers to sense system temperature from the same point in the system. Use of the Quad Thermistor Probe will allow each connected boiler to individually sense the actual water temperature in the storage tank or the hydronic heating loop. The temperatures sensed from each of the four temperature sensor circuits in a Quad Thermistor Probe are shown as the "Tank" temperature on each Boiler's default Temperatures Menu. See Figure 29 on page 40.

QUAD THERMISTOR PROBE



SIDE VIEW

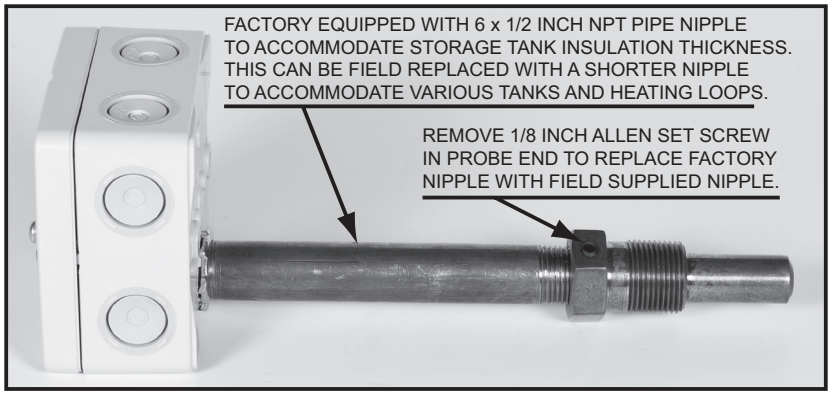


Figure 9

OPERATIONAL NOTES: When using multiple boilers with the Quad Thermistor Probe staggering each Boiler's Operating Setpoint by 1° to 3° will achieve greater system energy savings. The Boiler(s) with the lower Operating Setpoint will reduce their firing rate first and cycle off before the boiler(s) with higher settings. Setting up a monthly maintenance schedule to rotate which boiler(s) has the higher Operating Setpoint will also provide a means for lead/lag control which will maintain even wear/operating time for each boiler.

TABLE 3

WATER TEMPERATURE		TEMPERATURE SENSOR RESISTANCE IN OHMS
CELSIUS	FAHRENHEIT	
3°	40°	26,435
21°	70°	11,974
38°	100°	5,862
49°	120°	3,780
55°	130°	3,066
60°	140°	2,503
71°	160°	1,698
82°	180°	1,177

CONTROL PANEL

Figure 10 shows the Control Panel layout inside the VF Boiler. Three pressure switches are located in the upper right corner. Directly beneath the pressure switches is the Pump Relay that energizes factory installed Boiler Circulation Pumps or field supplied 120 VAC pumps up to 1 horsepower. For higher voltage/ horsepower pumps a field supplied starter must be used. The black and white 120 VAC pump wiring in the junction box on the back of the Boiler would be used to power the field supplied starter coil in this case. The MCB (Modulation Control Board) and the PDB (Power Distribution Board are also located on the Control Panel. The optional LWCO (Low Water Cut Off) circuit board is mounted on the Control Panel on models so equipped.

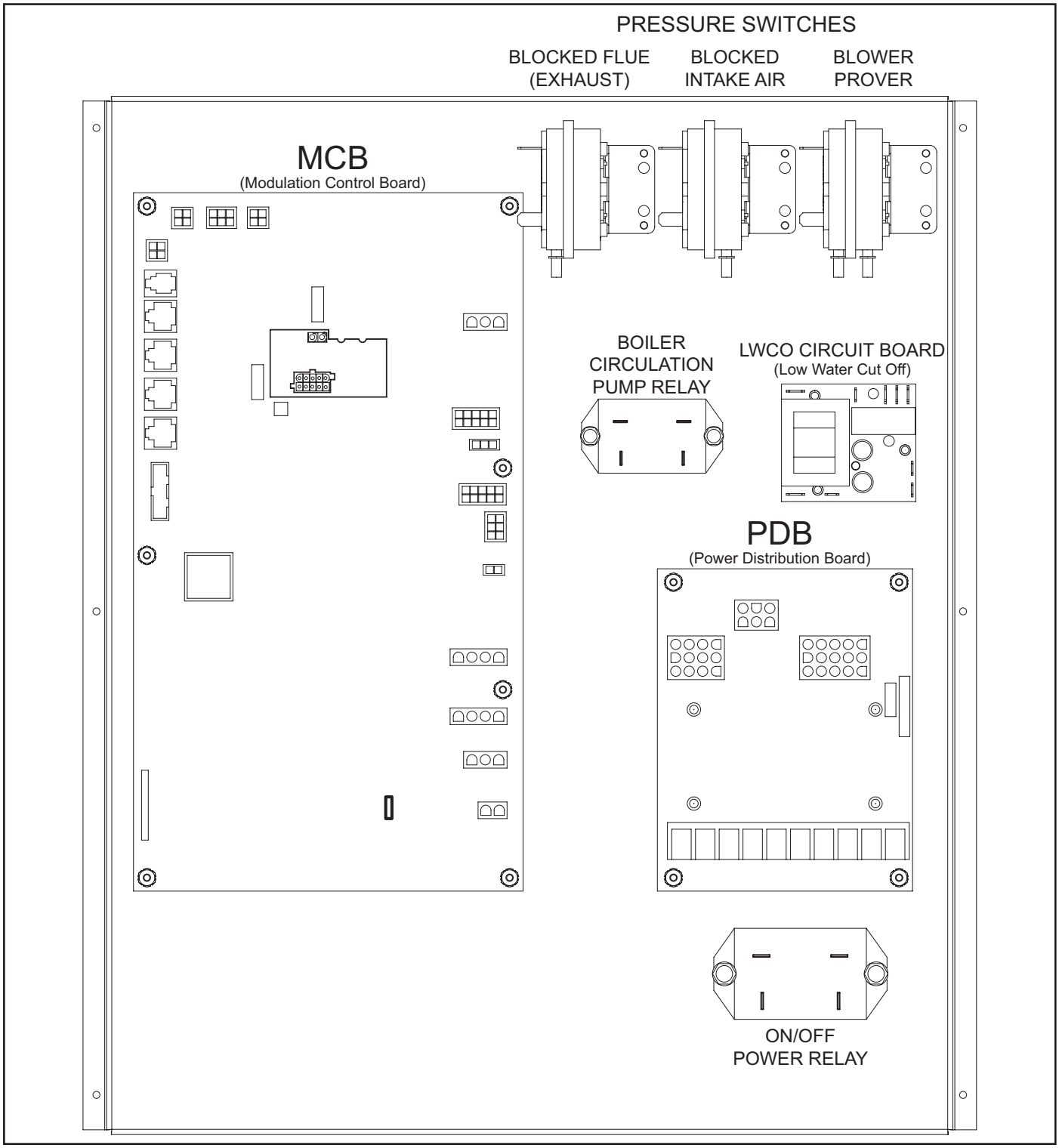


Figure 10

PRESSURE SWITCHES

There are three pressure switches installed on all VF Boilers to verify the venting (exhaust) and the intake air are not restricted and to confirm the Combustion Blower is operating properly when energized, see Figure 10 on page 17 and Figure 11 below.

The sensing tubes must be routed to the correct sensing ports and they must be properly connected at all times. Improper routing, kinks and disconnected sensing tubes will cause improper operation and associated Control System lock outs. The Blower Prover switch is a dual pressure switch, when testing performance two pressure readings are necessary. If the two sensing tubes connected to the Blower Prover switch are reversed, the Control System will lock out and display the "Blower Prover" error message on the LCD.

Figure 11 below illustrates the proper routing for the pressure switches and provides the operating parameters for each switch. Refer to this illustration when testing pressure switch performance or verifying proper sensing tube routing.

PRESSURE SWITCHES

OPERATIONAL PARAMETERS

Blocked Flue (Exhaust) Switch	
Normally Closed, Opens On Pressure Rise	
Single Pressure Sensing	
Natural Gas	Propane Gas
+3.5" W.C. ± 0.18	+4.0" W.C. ± 0.18

Blocked Intake Air Switch	
Normally Closed, Opens On Pressure Fall	
Single Pressure Sensing	
Natural Gas	Propane Gas
-4.0" W.C. ± 0.18	-5.7" W.C. ± 0.18

Blower Prover Switch	
Normally Open, Closes On Differential	
Dual Pressure Sensing	
Natural Gas	Propane Gas
-4.0" W.C. ± 0.18	-4.0" W.C. ± 0.18

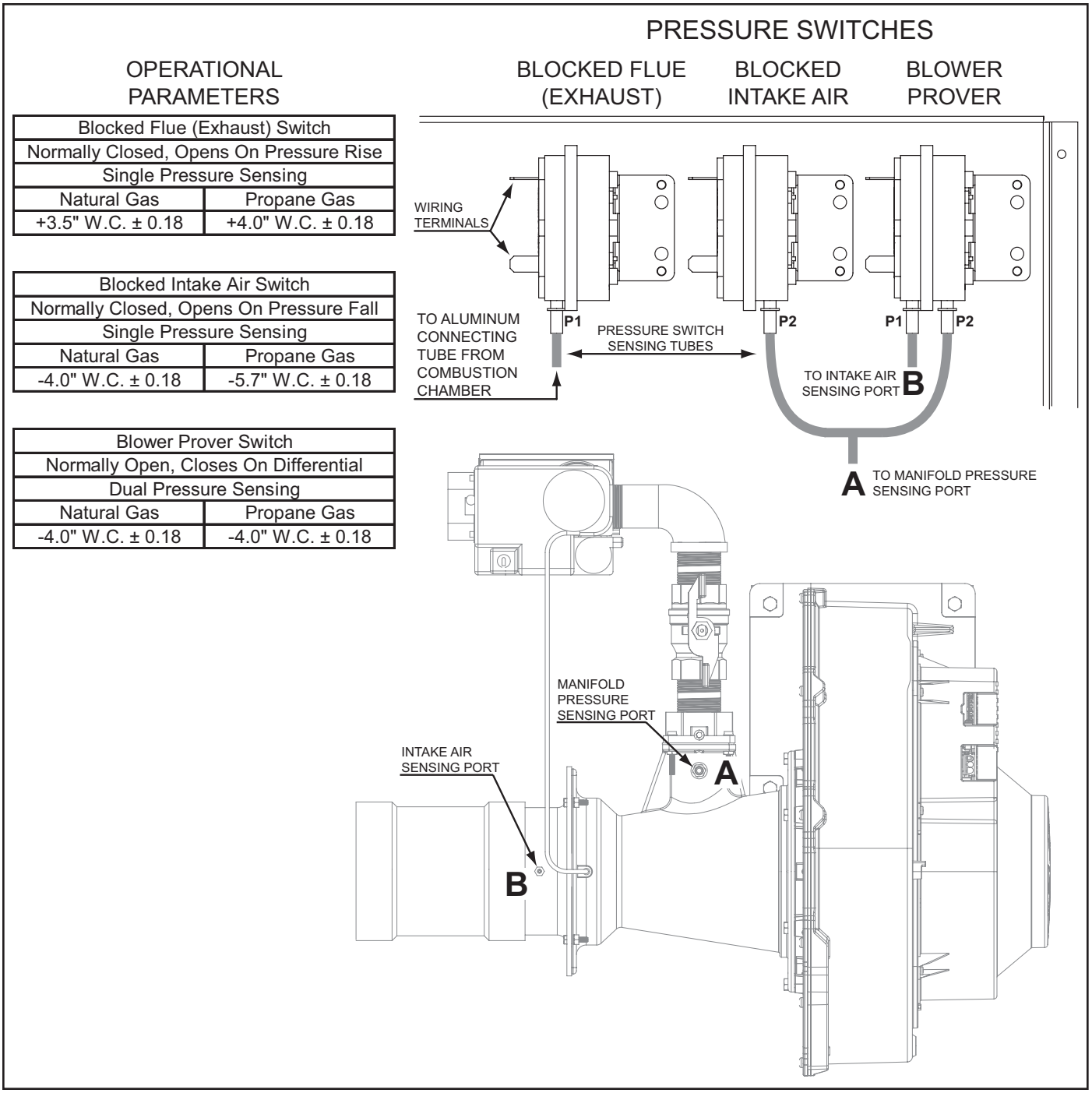


Figure 11

MCB - MODULATION CONTROL BOARD

The MCB circuit board is the main controller and is located on the Control Panel, see Figure 10 on page 17. All instructions for Burner modulation and temperature control originate from this circuit board. Diagnostic and operational messages are generated by the MCB and sent to the UIM. Most of the Boiler's components, such as the Igniter, Combustion Blower, 120 VAC Gas Valve, and Temperature Probes are directly connected to one of the MCB's socket connectors. The UIM (User Interface Module, see page 40) is also connected to one of the internal communication ports on the MCB. The Flame Sensors (see Figure 5 on page 11) are connected to the J16 spade connector on the MCB. Optional iCOMM™ system hardware, when used, is connected to one of the external communication ports on the MCB. The MCB circuit board has been divided into sections in the illustration below, each section will be covered in the pages that follow.

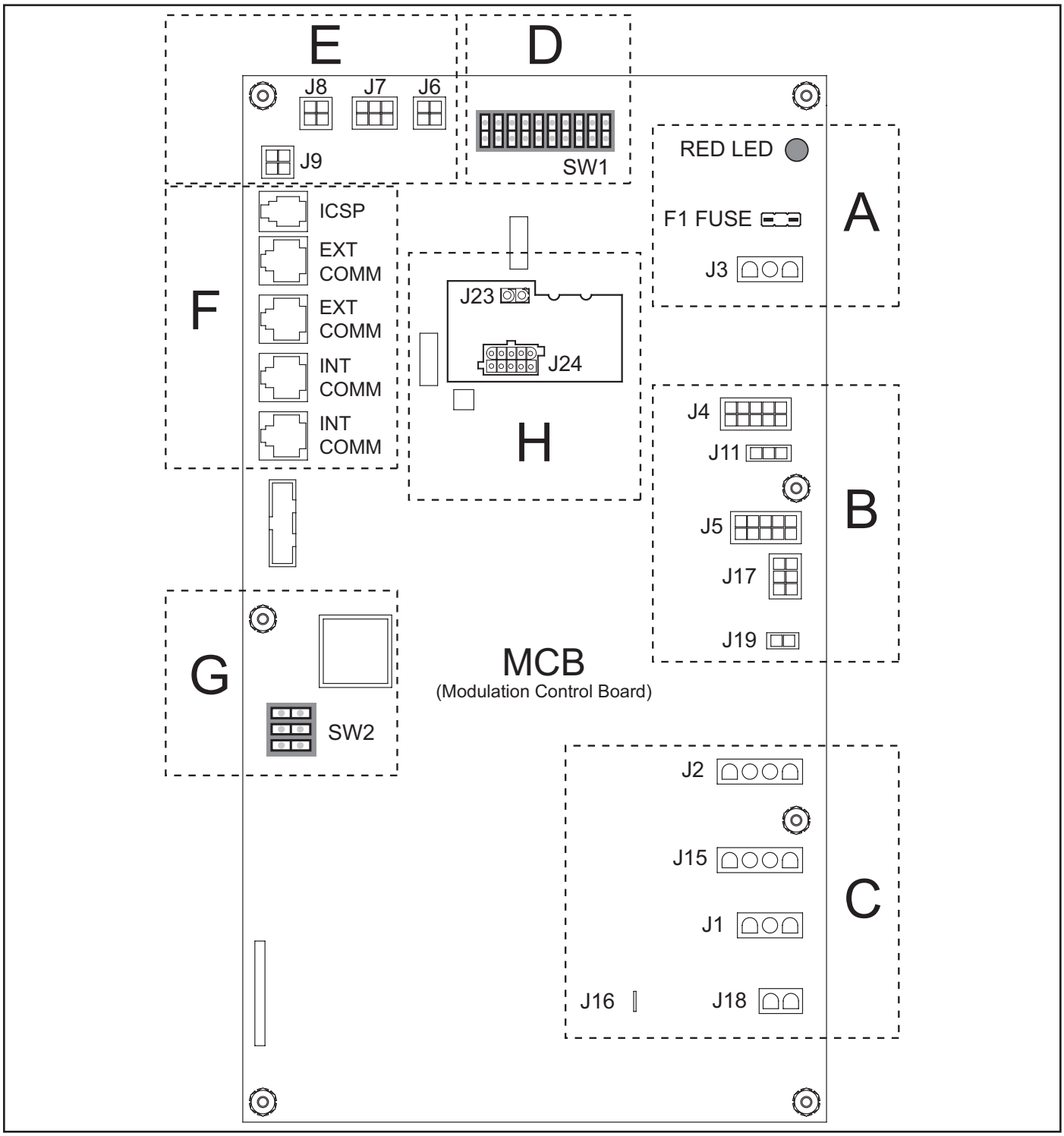


Figure 12

MCB - SECTION A

See Figure 12 on page 19 for location of this section on the MCB.

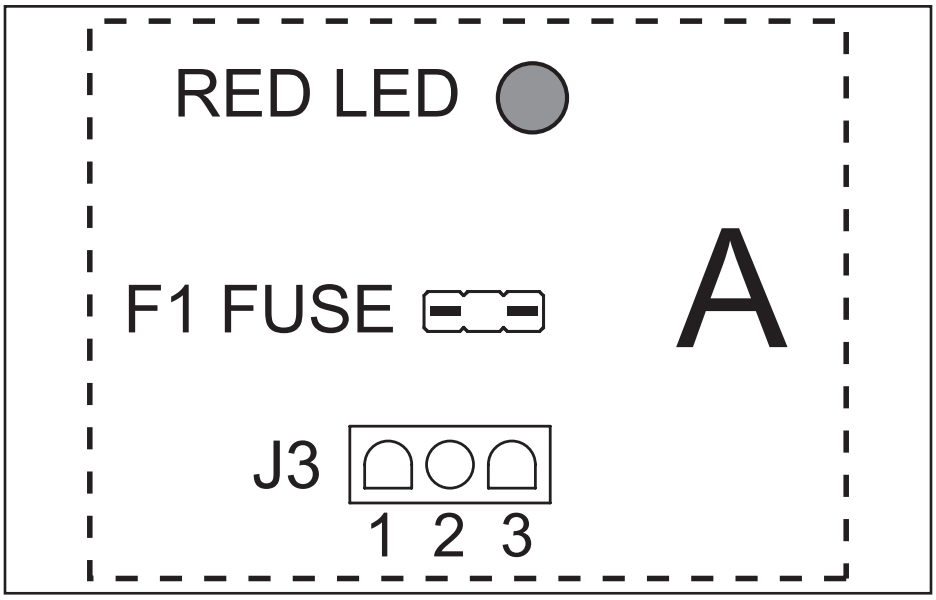


Figure 13

The upper right corner of the MCB contains the following sockets/components:

- **Red LED** (illuminated when the F1 fuse is open or not installed)
- **F1 Fuse** (7.5 amp automotive fuse - transformer secondary [24 VAC] winding protection)
- **J3 Socket** (24 VAC power supply from transformer)
  - Pin 1 - 24 VAC from PDB J2 Socket Pin 1
  - Pin 2 - 24 VAC from PDB J2 Socket Pin 2
  - Pin 3 - Ground from PDB J2 Socket Pin 3

MCB - SECTION B

See Figure 12 on page 19 for location of this section on the MCB.

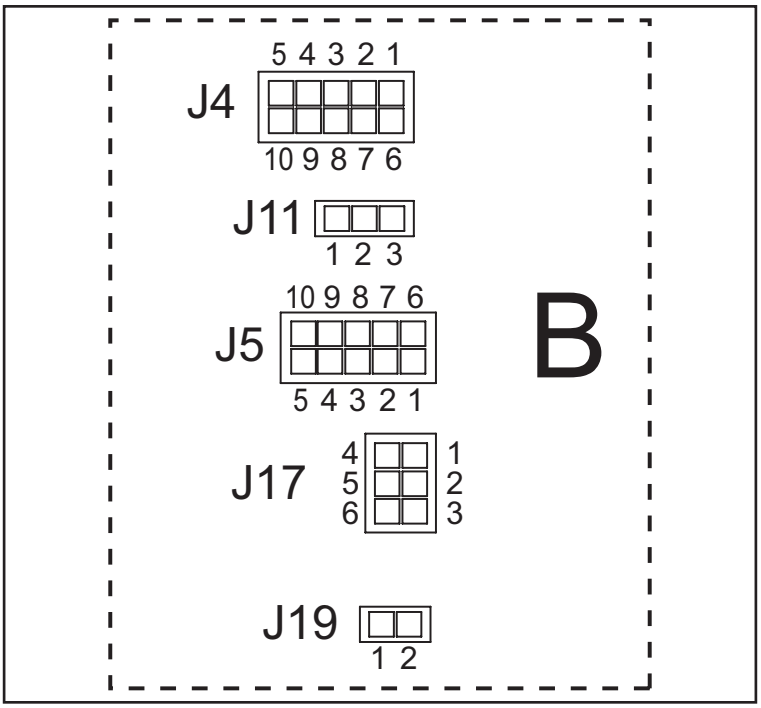


Figure 14

- **J4 Socket** (Outputs/Inputs)
  - Pin 1 - Power Accessory 24 VAC
  - Pin 2 - Power Accessory Prover
  - Pin 3 - Power Accessory 24 VAC RTN
  - Pin 4 - 24 VAC line low water cut off (optional)
  - Pin 5 - Low water cut off proving signal
  - Pin 6 - 24 VAC line low water cut off (optional)
  - † Pin 7 - 24 VAC alarm bell circuit (optional)
  - † Pin 8 - 24 VAC alarm bell circuit (optional)
  - Pin 9 - Spare - not used
  - Pin 10 - Spare - not used
- **J11 Socket** (Enable/Disable Circuit)
  - ‡ Pin 1 - 24 VAC to dry control contacts
  - ‡ Pin 2 - 24 VAC to dry control contacts
  - Pin 3 - Spare - not used
- **J19 Socket**
  - Pin 1 - 120 VAC - Gas Valve solenoid
  - Pin 2 - 120 VAC - Gas Valve solenoid
- **J5 Socket** (Inputs)
  - Pin 1 - 24 VAC Flow Switch
  - Pin 2 - 24 VAC Flow Switch
  - Pin 3 - 24 VAC Low Gas Pressure Switch
  - Pin 4 - 24 VAC Low Gas Pressure Switch
  - Pin 5 - 24 VAC Blocked Flue (Exhaust) Switch
  - Pin 6 - 24 VAC Blocked Flue (Exhaust) Switch
  - Pin 7 - Spare - Not used
  - Pin 8 - Spare - Not used
  - Pin 9 - Spare - Not used
  - Pin 10 - Spare - Not used
- **J17 Socket** (Blower Prover/Hi Gas Press Switch)
  - Pin 1 - 24 VAC Blower Prover Switch
  - Pin 2 - 24 VAC Blower Prover Switch
  - Pin 3 - 24 VAC High gas press switch (optional)
  - Pin 4 - 24 VAC High gas press switch (optional)
  - Pin 5 - 24 VAC Blocked Intake Air Switch
  - Pin 6 - 24 VAC Blocked Intake Air Switch

† J4 Socket Pins 7 & 8 provide 24 VAC for an optional alarm bell that will sound whenever the Boiler Control System declares a fault condition. This is a switched 24 VAC control circuit with a maximum amp rating of 1 AC amp @ 24 VAC.

‡ The enable/disable circuit is provided for use with external supervisory controls. Field wring is installed between this circuit and a set of "dry contacts" on the external control, see Figure 1 on page 6. This is a switching circuit only: Do not apply any external voltage or connect any load (IE: relay coil) to this circuit. This will permanently damage the MCB circuit board and is not covered under the limited warranty.

MCB - SECTION C

See Figure 12 on page 19 for location of this section on the MCB.

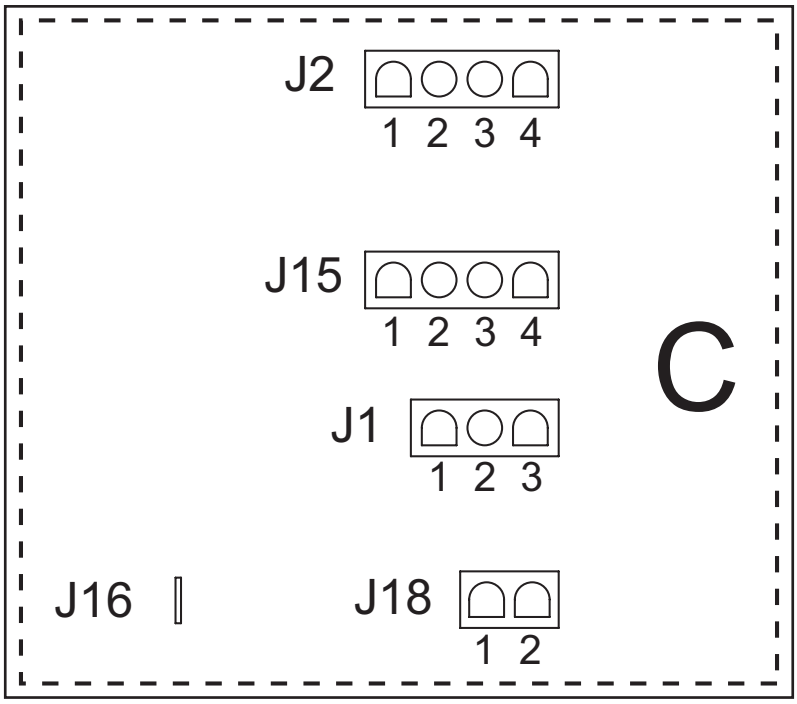


Figure 15

- **J2 Socket** (Boiler Circulation Pump relay coil - see Figure 10 on page 17 for location)
  - Pin 1 - 120 VAC switched hot wire to pump relay coil
  - Pin 2 - 120 VAC neutral wire to pump relay coil
  - Pin 3 - Spare - not used
  - Pin 4 - Spare - not used
- **J15 Socket** Not used
- **J1 Socket** (120 VAC power supply from PDB)
  - Pin 1 - 120 VAC hot wire
  - Pin 2 - 120 VAC neutral wire
  - Pin 3 - Ground
- **J18 Socket** (120 VAC to hot surface igniter)
  - Pin 1 - Igniter 120 VAC hot wire
  - Pin 2 - Igniter 120 VAC neutral wire
- **J16 Flame** - Flame Sensor connection (single wire connect - split wire serves two Flame Sensors), see Figure 5 on page 11.

MCB - SECTION D

See Figure 12 on page 19 for location of this section on the MCB.

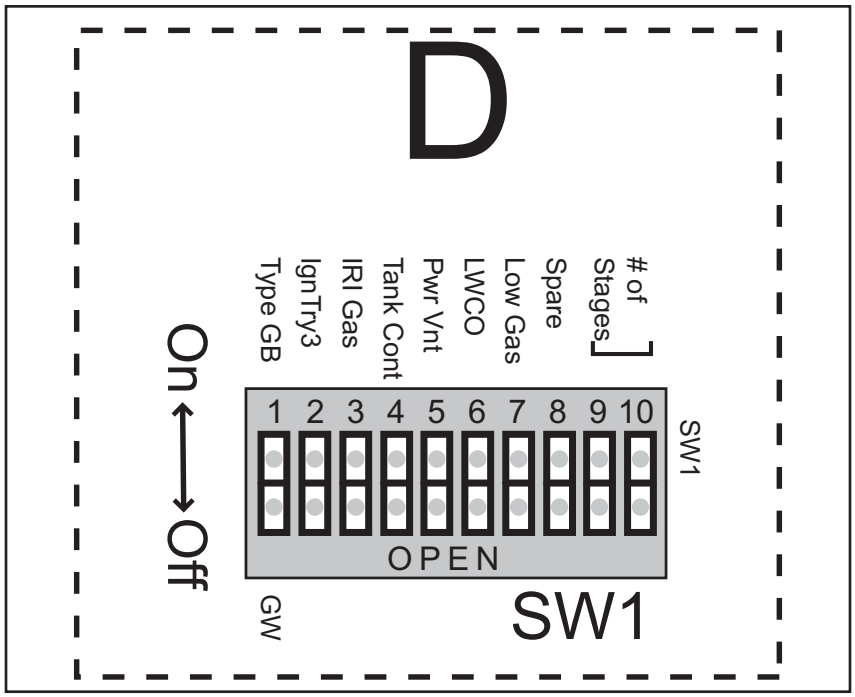


Figure 16

System configurations are set on the MCB circuit board with dip switches. SW1 dipswitch settings can be viewed physically on the MCB. Settings can also be confirmed from the Control System's “Config Settings” menu, see Control System Menus on page 44.

TABLE 4

SW1 DIPSWITCHES			
Switch 1	Type of boiler application VB or VW. This switch will change the Operating Setpoint and the Hi Limit settings range for hot water supply (lower range) and hydronic heating (higher range) applications.	On = VB Oper Setpnt 105-215 Setpnt Diff 1-50 Hi Limit 135-235 Hi Limit Dif 20-50	Off = VW Oper Setpnt 105-190 Setpnt Diff 1-50 Hi Limit 135-210 Hi Limit Dif 20-50
Switch 2	Number of trials for ignition	On = 3 trials	Off = 1 trial
Switch 3	Not Used		
Switch 4	Controlling Probe. This switch will designate a remote temperature probe or the boiler's factory installed inlet temperature probe as the "Controlling Probe."	On = Remote Temperature Probe or Quad Thermistor Probe	Off = Inlet Temperature Probe
Switch 5	Power Accessory Present	On = Yes	Off = No
Switch 6	Low water cut off present	On = Yes	Off = No
Switch 7	Low Gas Pressure Switch present	On = Yes	Off = No
Switch 8	Not Used		
Switch 9	Not Used		
Switch 10	Not Used		

MCB - SECTION E

See Figure 12 on page 19 for location of this section on the MCB.

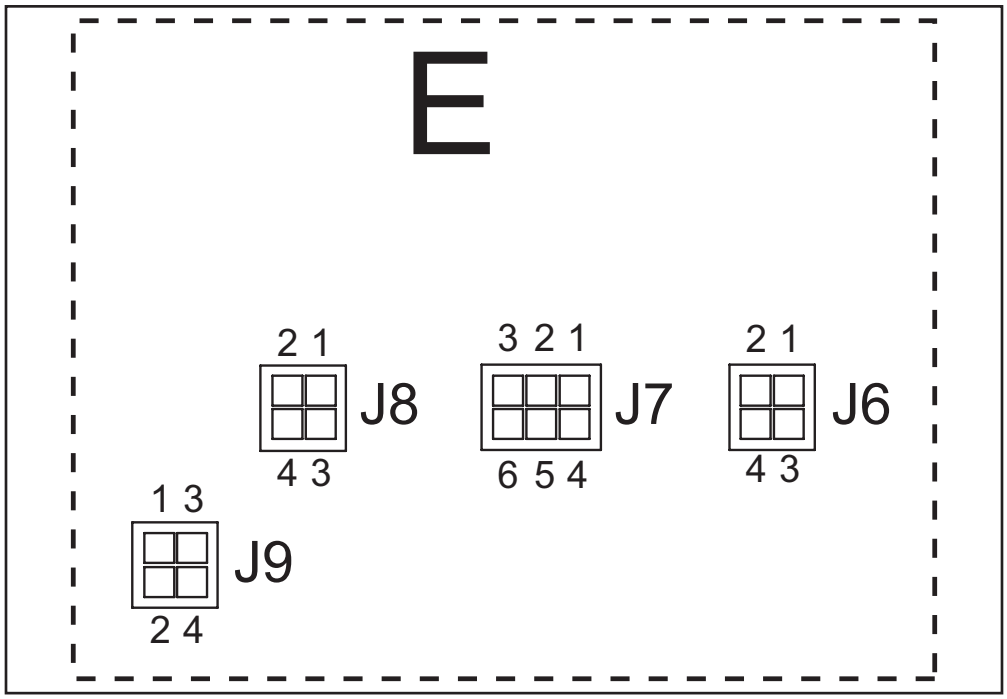


Figure 17

- **J6 Socket** (Not Used)
  - Pin 1 - N/A - not used
  - Pin 2 - N/A - not used
  - Pin 3 - N/A - not used
  - Pin 4 - N/A - not used
- **J7 Socket** (Outlet Temperature Probe, Manual Reset High Limit)
  - Pin 1 - 24 VDC manual reset high limit
  - Pin 2 - 24 VDC manual reset high limit
  - Pin 3 - Not used
  - Pin 4 - 5 VDC Outlet Temperature Probe
  - Pin 5 - 5 VDC Outlet Temperature Probe
  - Pin 6 - Not used
- **J8 Socket** (Inlet Temperature Probe)
  - Pin 1 - Not used
  - Pin 2 - 5 VDC Inlet Temperature Probe
  - Pin 3 - 5 VDC Inlet Temperature Probe
  - Pin 4 - N/A - not used
- **† J9 Socket** (Remote Temperature Probe or Quad Thermistor Probe)
  - Pin 1 - N/A - not used
  - Pin 2 - Not used
  - Pin 3 - 5 VDC remote/quad temperature probe
  - Pin 4 - 5 VDC remote/quad temperature probe

† J9 Socket Pins 3 & 4 - the Remote Temperature Probe or the optional Quad Thermistor Probe connects to this socket. Two yellow wires from this socket are routed to the junction box on the back of the Boiler. Dedicated field wiring and conduit must be installed between the Remote Temperature Probe or the optional Quad Thermistor Probe and the junction box. The Remote Temperature Probe is factory supplied with all VF Boilers. Either the Remote Temperature Probe or the optional Quad Thermistor Probe is used as the “Controlling Probe” on VF Boilers, see Boiler Controls on page 6. The SW1 dip switch #4 must be turned on to activate one of these two probes after installation, see Table 4 on page 23.

MCB - SECTION F

See Figure 12 on page 19 for location of this section on the MCB.

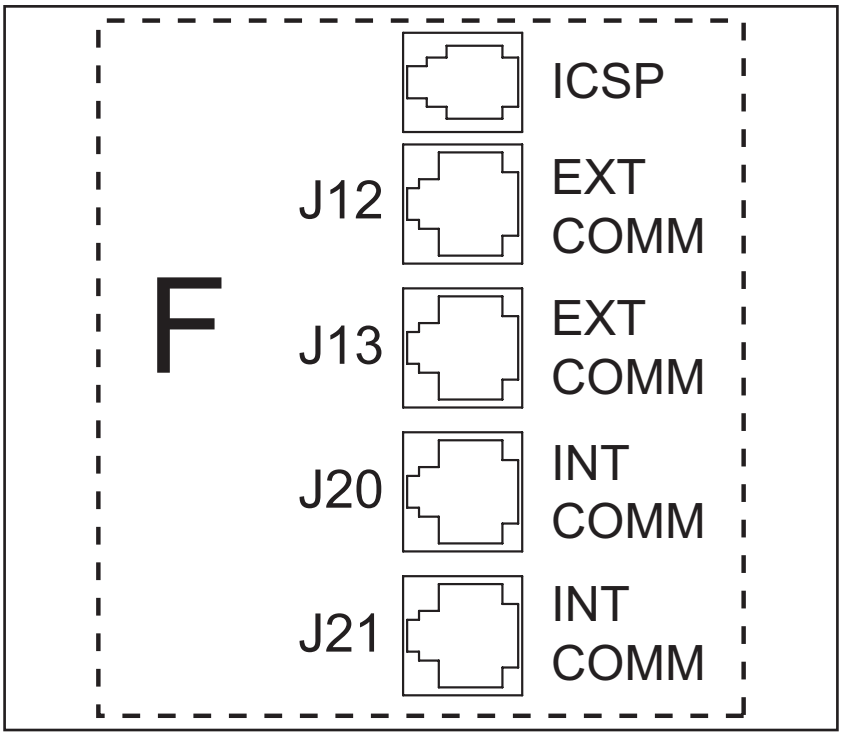


Figure 18

ICSP Port

The ICSP port (In Circuit Serial Programming) is used for programming the MCB. **DO NOT** plug any device or cable into this port. This port is used by engineering personnel only. Plugging cables/devices into this port will permanently damage the MCB and is not covered under the Limited Warranty.

J12 & J13 Sockets - External Communication Ports

These ports are used to connect external communication devices such as the iCOMM™ remote monitoring system hardware. Boilers are networked together using standard Category 5/6 network cable. One External Comm Port would receive a cable from the previous boiler/appliance and the second port would be connected to the next boiler/appliance in the network. These are parallel ports used to connect external components that communicate with the MCB. Because these ports are parallel it does not matter which one is used to connect an external component.

For a boiler to be recognized on the network it's default network address of 0 must be changed to a number between 1 and 31 in the "User Settings" menu from the UIM. Each boiler on an iCOMM™ network must have a unique network address.

J20 & J21 Sockets - Internal Communication Ports

These are parallel ports used to connect internal components that communicate with the MCB. One is used for connecting the UIM (User Interface Module - see page 40) to the MCB. Because these ports are parallel it does not matter which one connects to the UIM.

MCB - SECTION G

See Figure 12 on page 19 for location of this section on the MCB.

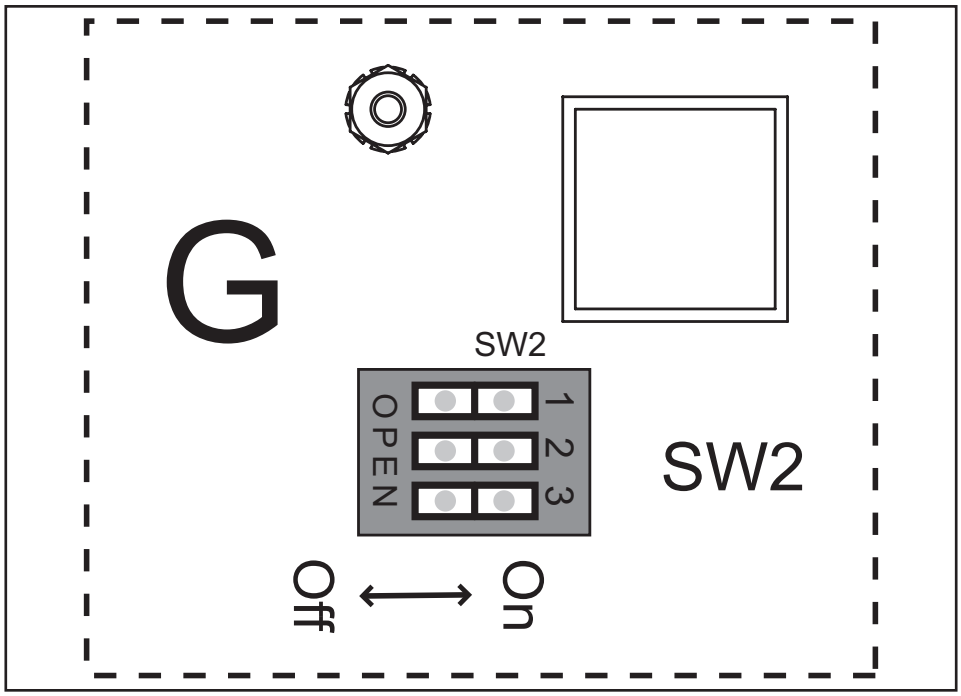


Figure 19

Along the left edge of the MCB there is a second dip switch array; SW2. There are three SW2 dipswitches. Switch 1 and 3 are not used. Switch 2 is turned on if there is an optional High Gas Pressure switch installed on the Boiler. This switch must be configured correctly. To configure a boiler that has the optional High Gas Pressure switch, turn the SW2 # 2 dipswitch to the "On" position. Do not turn this switch on if there is no High Gas Pressure switch installed, this will cause false "High Gas" error messages and Control System lock outs.

SW2 dipswitch settings can be viewed physically on the MCB. Settings can also be confirmed from the Control System's “Config Settings” menu, see Control System Menus on page 44.

TABLE 5

SW2 DIPSWITCHES			
Switch 1	Not Used		
Switch 2	High gas pressure switch present	On = Yes	Off = No
Switch 3	Not Used		

MCB - SECTION H

See Figure 12 on page 19 for location of this section on the MCB.

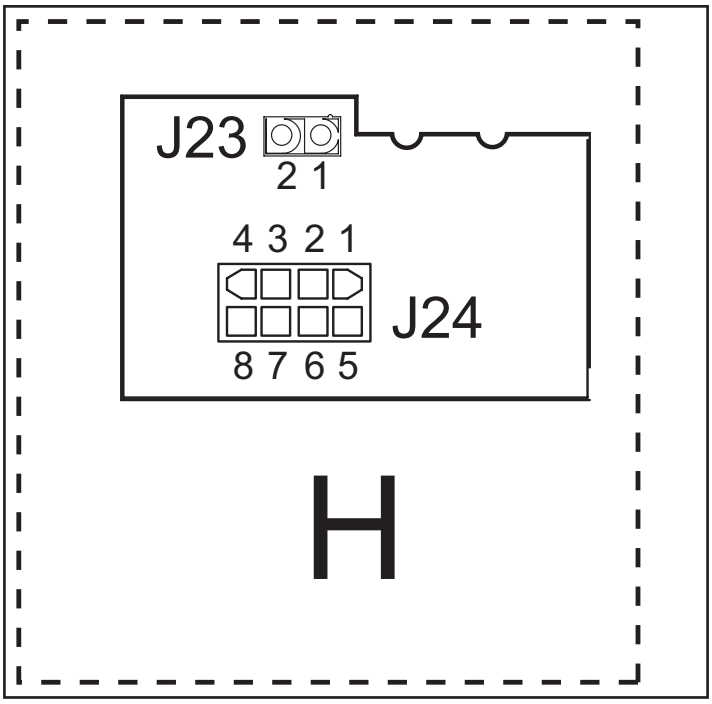


Figure 20

This section of the MCB contains the J23 and J24 sockets. The J23 Socket is used to connect the Config Key, see Config Key on page 13. A wiring harness connects the J24 Socket on the MCB to the 5 pin socket on the Combustion Blower assembly, see Figure 4 on page 10. This wring harness conveys instructions from the MCB to start/stop and control blower speed which in turn controls the firing rate of the Boiler, see Venturi & Gas Train on page 12.

- **J23 Socket** (Config Key)
  - Pin 1 - Config Key
  - Pin 2 - Config Key
- **J24 Socket** (Combustion Blower Speed Control)
  - Pin 1 - 0 - 10 VDC RTN
  - Pin 2 - 0 - 10 VDC
  - Pin 3 - Not used
  - Pin 4 - Not used
  - Pin 5 - Not used
  - Pin 6 - +24 VDC
  - Pin 7 - RPM Feedback
  - Pin 8 - Not used

PDB - POWER DISTRIBUTION BOARD

The PDB provides connection points for line-input (120 VAC) power, the Boiler Circulation Pump, the Combustion Blower and the Transformer. The PDB also distributes the Transformer output (24 VAC) power to necessary locations. It also contains fuses for various Boiler components. The PDB is located on the Control Panel, see Figure 10 on page 17.

The PDB circuit board has been divided into sections in the illustration below, each section will be covered in the pages that follow.

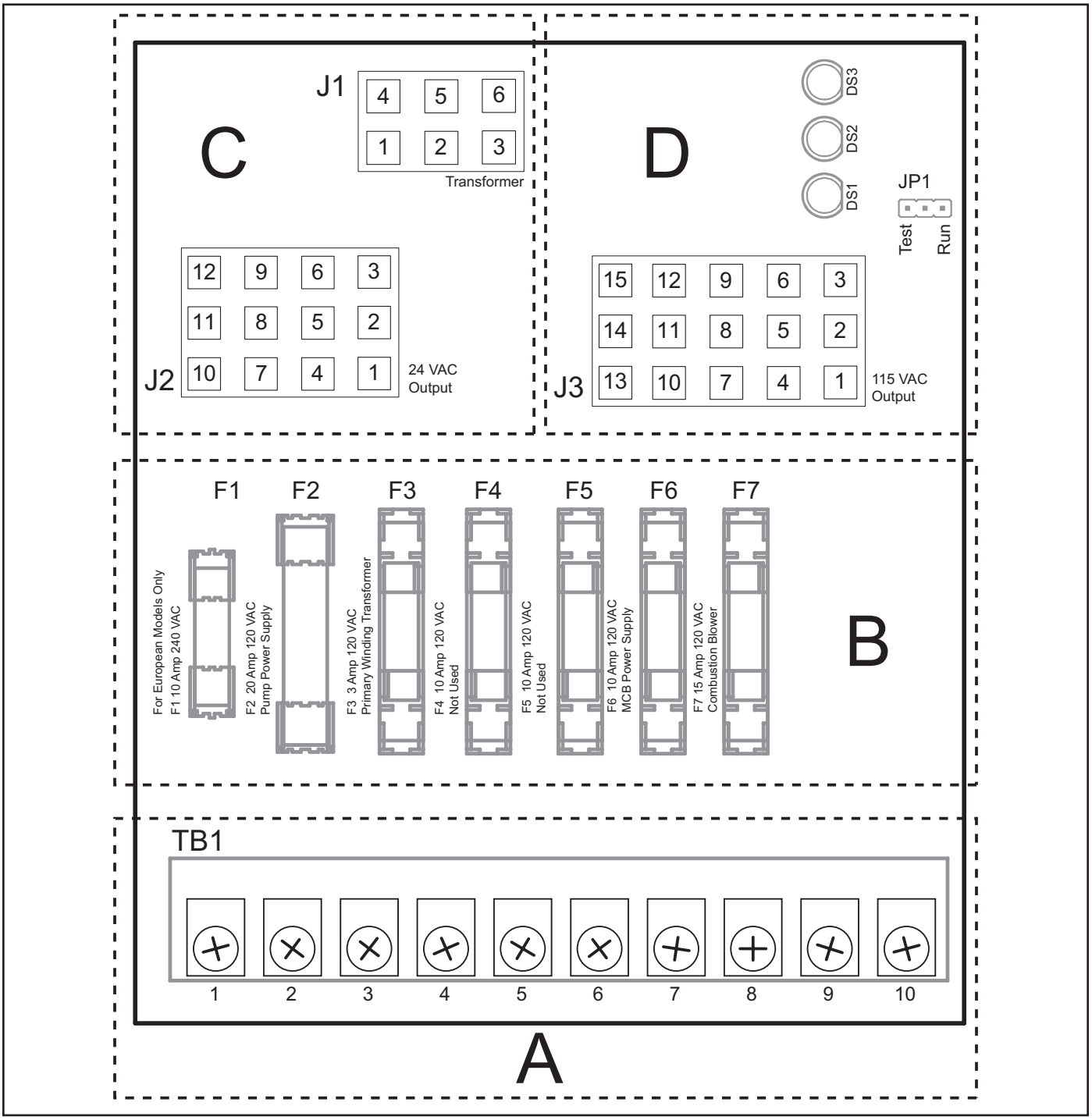


Figure 21

PDB - SECTION A

See Figure 21 on page 28 for location of this section on the PDB.

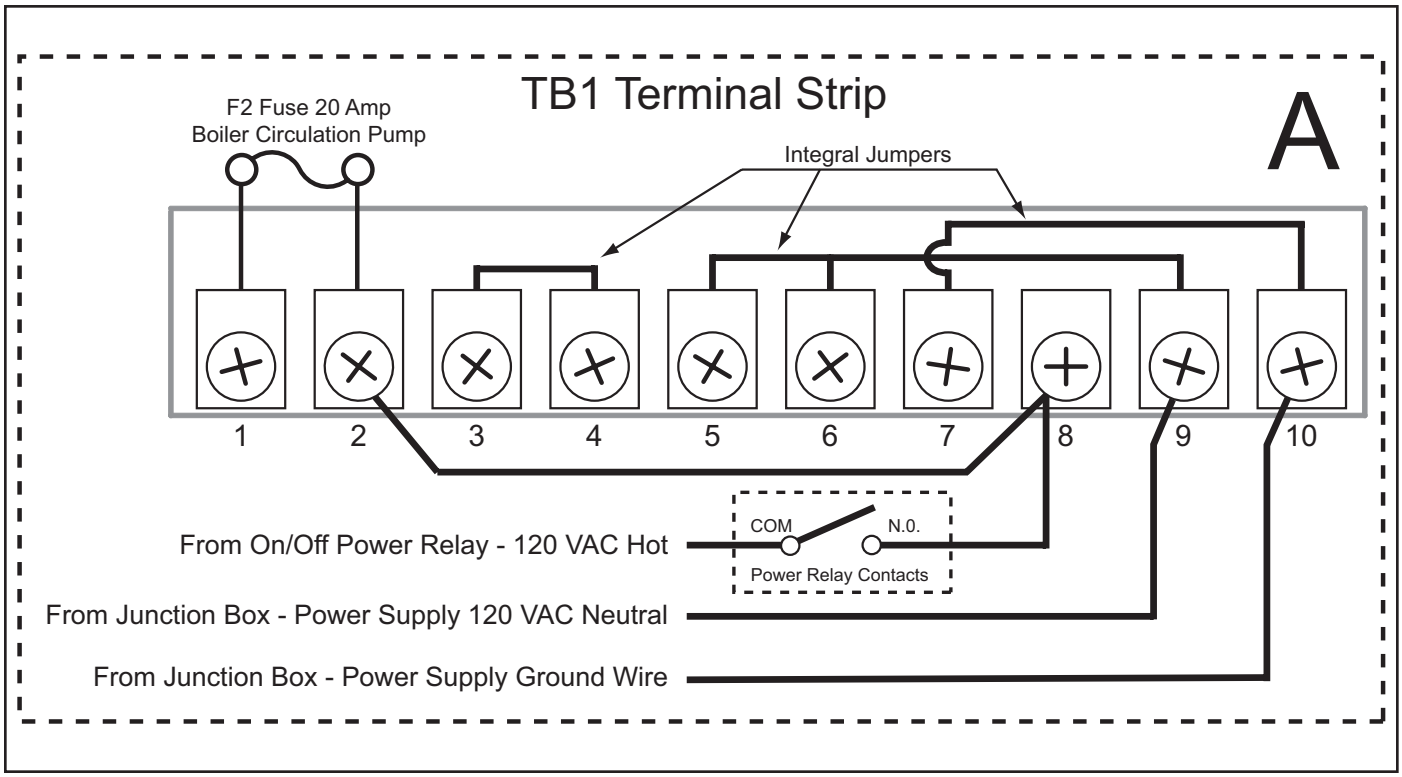


Figure 22

The bottom of the PDB circuit board contains a terminal strip (TB1) used to connect the 120 VAC power supply and earth ground to the Boiler, the Boiler Circulation Pump Relay, and the Boiler Circulation Pump motor. VW models will have a factory mounted pump powered by the Boiler Circulation Pump Relay; factory mounted pumps are optional on VB models. See Control Panel on page 17 for location of the Boiler Circulation Pump Relay.

See the complete wiring diagram that came with the Boiler and is also printed in the Instruction Manual that came with the Boiler.

TB1 TERMINAL STRIP

1. 120 VAC hot wire to N.O. contact on Pump Relay.
2. 120 VAC hot wire from TB1 terminal 8.
3. 120 VAC hot wire to Common contact on Pump Relay.
4. 120 VAC hot wire from factory installed Boiler Circulation Pump motor.
5. 120 VAC neutral wire from factory installed Boiler Circulation Pump motor.
6. 120 VAC neutral wire from Boiler Power Supply.
7. Ground wire from Boiler Circulation Pump.
8. 120 VAC hot wire from boiler On/Off power relay's N.O. (normally open) contact.
9. 120 VAC neutral wire from Boiler Power Supply.
10. Ground wire from Boiler Power Supply.

PDB - SECTION B

See Figure 21 on page 28 for location of this section on the PDB.

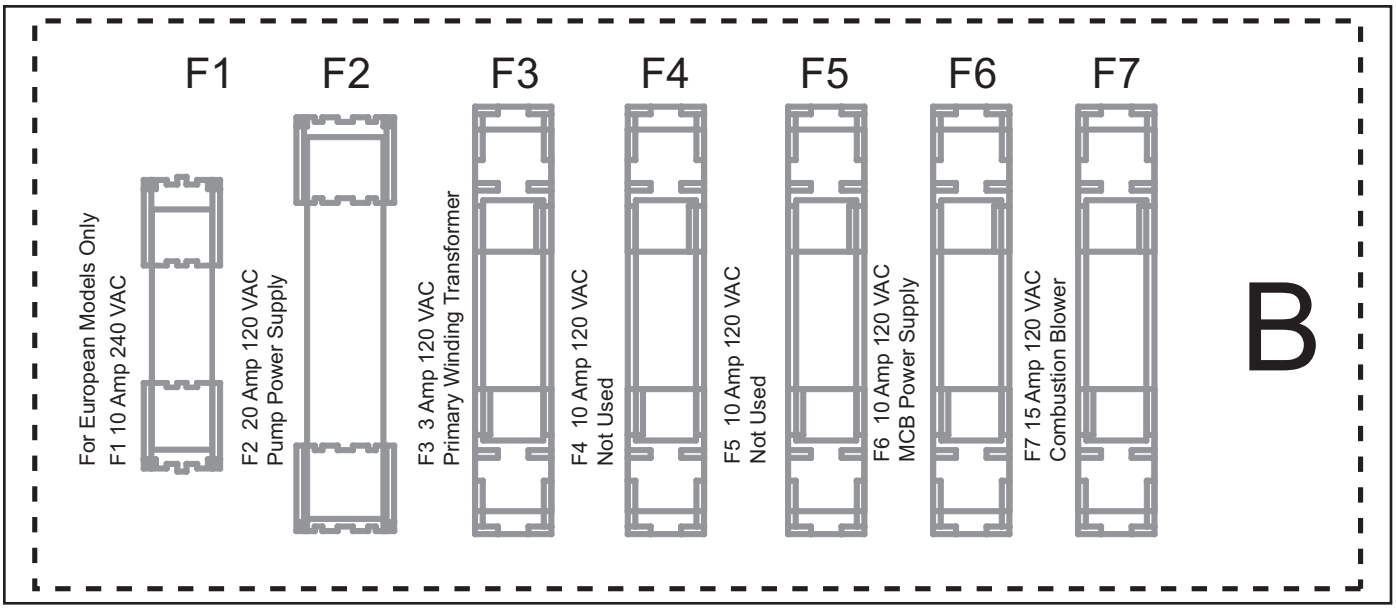


Figure 23

The mid section of the PDB contains the fusing for the following:

- **F1 Fuse** - 10 amp 240 VAC - European Models only
- **F2 Fuse** - 20 amp 120 VAC - Pump Power Supply
- **F3 Fuse** - 3 amp 120 VAC - Transformer Primary Winding
- **F4 Fuse** - 10 amp 120 VAC - Not Used
- **F5 Fuse** - 10 amp 120 VAC - Not Used
- **F6 Fuse** - 10 amp 120 VAC - MCB Power Supply
- **F7 Fuse** - 15 amp 120 VAC - Combustion Blower

FIELD SUPPLIED BOILER CIRCULATION PUMPS

Field supplied 120 VAC Boiler Circulation Pumps with FLA (full load amp) ratings of 10 AC amps or less may use the onboard pump relay for line voltage. See the Boiler Circulation Pump Relay location in Figure 10 on page 17 and the wiring diagram that came with the Boiler.

For field supplied boiler circulation pumps with FLA ratings greater than 15 AC amps or greater than 120 VAC the onboard pump relay may only be used as a pilot relay to energize a 120 VAC coil on an external relay/ starter. **DO NOT** use the Boiler's power supply as a line voltage source for field supplied boiler circulation pumps with greater amperage or voltage ratings that described here; use a separate power supply/breaker for line voltage in this circumstance.

Connect the ground, hot and neutral wires from a field supplied 120 VAC boiler circulation pump to the to the designated 120 VAC pump power supply wiring in the junction box on the back of the Boiler.

When using the onboard pump relay as a pilot relay, connect the designated 120 VAC pump power supply wiring in the junction box on the back of the Boiler to energize the external relay/starter coil.

Follow all applicable electrical codes when installing field supplied boiler circulation pumps.

PDB - SECTION C

See Figure 21 on page 28 for location of this section on the PDB.

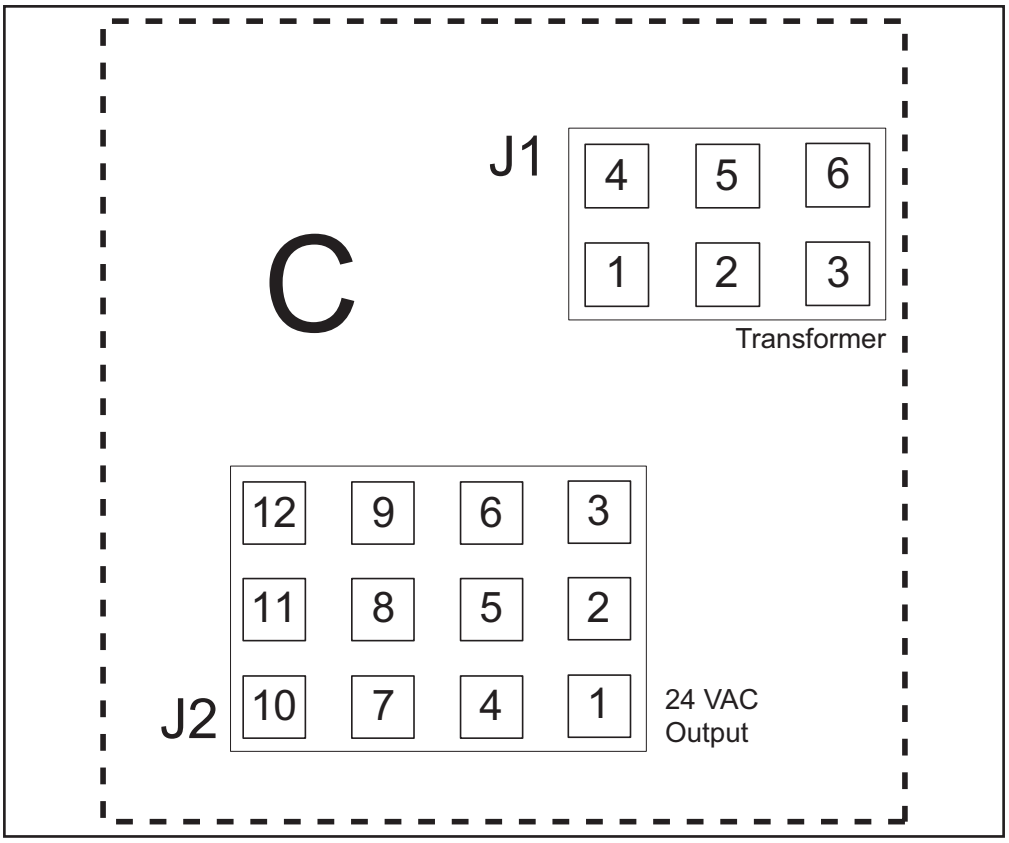


Figure 24

The upper left corner of the PDB contains the following:

- **J1 Socket** (Transformer 120 VAC x 24 VAC - 100VA)
  - Pin 1 - 24 VAC Common
  - Pin 2 - 24 VAC Hot
  - Pin 3 - 120 VAC Hot to Transformer
  - Pin 4 - 24 VAC Common
  - Pin 5 - 24 VAC Hot
  - Pin 6 - 120 VAC Neutral to Transformer
- **J2 Socket** (24 VAC Outputs)
  - Pin 1 - 24 VAC Hot to MCB J3 Socket Pin 1
  - Pin 2 - 24 VAC Return to MCB J3 Socket Pin 2
  - Pin 3 - Ground to MCB J3 Socket Pin 3
  - Pin 4 - Not Used
  - Pin 5 - Not Used
  - Pin 6 - 24 VAC RTN for BMI (Building Management Interface) option
  - Pin 7 - 24 VAC for BMI for BMI (Building Management Interface) option
  - Pin 8 - Not Used
  - Pin 9 - Not Used
  - Pin 10 - Not Used
  - Pin 11 - Not Used
  - Pin 12 - Not Used

PDB - SECTION D

See Figure 21 on page 28 for location of this section on the PDB.

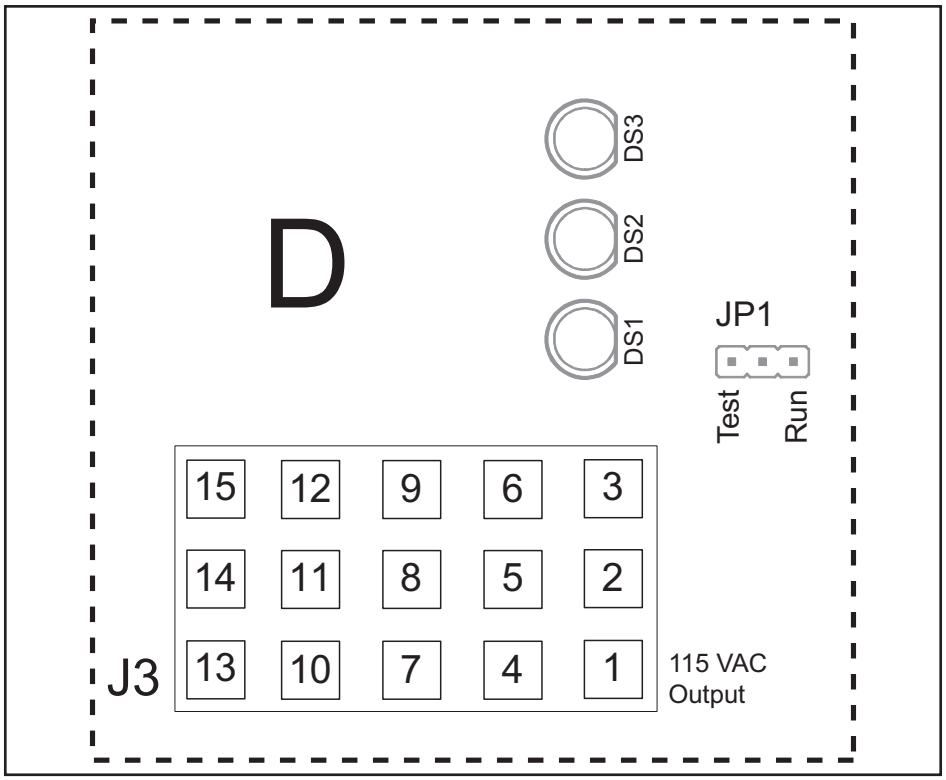


Figure 25

The upper right corner of the PDB contains the J3 Socket and the JP1 jumper. The J3 Socket is described here. The JP1 jumper is described on page 33.

- **J3 Socket** (120 VAC Outputs)
  - Pin 1 - 120 VAC Hot to Combustion Blower Assembly 3 Pin Socket (see Figure 4 on page 10)
  - Pin 2 - 120 VAC Neutral to Combustion Blower Assembly 3 Pin Socket (see Figure 4 on page 10)
  - Pin 3 - Earth Ground to Combustion Blower Assembly 3 Pin Socket (see Figure 4 on page 10)
  - Pin 4 - 120 VAC Hot to MCB J1 Socket Pin 1 (see Figure 15 on page 22)
  - Pin 5 - 120 VAC Neutral to MCB J1 Socket Pin 2 (see Figure 15 on page 22)
  - Pin 6 - Earth Ground to MCB J1 Socket Pin 3 (see Figure 15 on page 22)
  - Pin 7 - Not Used
  - Pin 8 - Not Used
  - Pin 9 - Not Used
  - Pin 10 - Not Used
  - Pin 11 - Not Used
  - Pin 12 - Not Used
  - Pin 13 - Not Used
  - Pin 14 - Not Used
  - Pin 15 - Safety Ground for BMI (Building Management Interface) option

POWER SUPPLY TEST

See Figure 21 on page 28 for location of the JP1 jumper and the power supply status LED lights on the PDB circuit board shown below. This illustration is rotated 90° clockwise.

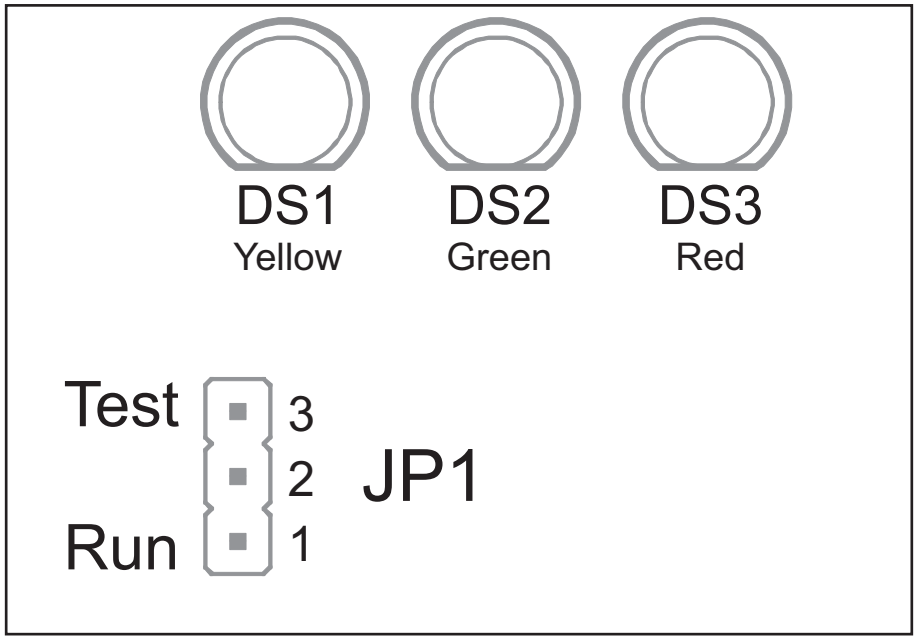


Figure 26

The upper right corner of the PDB contains three JP1 jumper pins, a two pin jumper and three power supply status LED lights. With power applied the green DS2 LED should always be lit. The JP1 jumper pins and jumper are used to activate a power supply test function.

POWER TEST PROCEDURE

Turn power off to the Boiler at the Boiler's on/off switch. Disconnect the wiring harness plugs at the J1, J2, and J3 Sockets on the PDB. Remove the two pin jumper from JP1 pins 1 and 2 (normal setting) and place it to short across JP1 pins 2 and 3 (power test setting). Turn power back on and note which of the three LEDs, labeled DS1, DS2 and DS3 are illuminated. If the power supply is properly connected the Yellow and Green LEDs (DS1 and DS2) should be illuminated and the red (DS3) LED should be off. If any other combination of LEDs are illuminated refer to Table 6 below to determine the nature of the problem and what corrective action must be taken.

NOTE: The two pin jumper should be in the "Run" (shorted across JP1 pins 1 and 2) position during normal operation. Leaving the jumper in the test mode when operating the system may cause trouble with Ground Fault Interrupters.

The wire harnesses that normally connect to J1, J2, & J3 should be disconnected while performing this test. Power test results will not be accurate if these three wiring harness plugs are not disconnected during the test procedure.

TABLE 6

LINE CONNECTION STATUS	DS1 YELLOW LED	DS2 GREEN LED	DS3 RED LED
Proper Connection	ON	ON	OFF
Open Ground	OFF	ON	OFF
Reverse Polarity	OFF	ON	ON
Open Hot	OFF	OFF	OFF
Open Neutral	ON	ON	ON
Reverse Hot & Ground	ON	OFF	ON
Hot wire on Neutral connect & Open Neutral wire	OFF	OFF	ON

START UP

PRIOR TO START UP

In addition to normal supplies and hand tools necessary for installing and servicing water heaters and boilers the following tools and test equipment should be on hand. See Tools Required on page 3 for detailed tool requirements.

- A combustion analyzer capable of measuring draft pressure, CO, and CO2 or O2.
- True RMS Digital Multi Meter DMM capable of reading AC volts, DC volts, ohms, and DC micro amps µA DC.
- AC amp meter.
- TORX® T40 or 5mm hex (Allen) wrench - for setting gas mixture at gas valve.
- 3mm or 7/64in hex (Allen) wrench - for setting gas mixture at gas valve.
- 2 digital manometers for measuring supply and manifold gas pressures.
- 1/4" and 3/8" plastic/silicone/rubber flexible tubing - used to connect manometers to pressure sensing ports on Boiler during start up and service.
- 1/4" and 3/8" plastic barbed Tee fitting - standard automotive emission grade fittings - used to connect manometers to pressure sensing ports on Boiler during start up and service.

MODULATE MODE

When performing a Start Up on VF Boilers, the Boiler's Modulate Mode in the User Settings menu must be forced into the Min Mode (minimum firing rate - 25%) and the Max Mode (maximum firing rate - 100%). See Control System Menus on page 44.

MODULATE MODE ADJUSTMENT

Press the Menu button on the UIM (see page 42). Using the Up and Down buttons scroll down until the > cursor to the left of the display is lined up with the User Settings menu and press the Select button. Scroll down to Modulate Mode menu item and press the Select button again. The > cursor starts flashing on and off slowly indicating the adjustment mode for this menu item has been activated. Use the up and down buttons to select between these three options:

- Min (forced minimum firing rate - 25%)
- Max (forced maximum firing rate - 100%)
- Mod (MCB automatic controlled firing rate - modulation mode)

Press the Select button once more to confirm the setting chosen. The > cursor stops flashing and the Control System then enters the Modulate Mode selected.

The Min Mode and Max Mode are used during start up to adjust gas flow (if necessary) and check combustion. Return the Modulate Mode setting to the Mod Mode after checking combustion. The Control System is programmed to automatically return to the Mod Mode after 10 minutes. Read the entire Control System Operation section in this manual between pages 39 and 44 before Start Up begins.

TURNING THE BOILER OFF

NEVER TURN OFF POWER TO THE BOILER WHILE IT IS FIRING unless an emergency shut down is required. Repeated sudden stops while firing can damage the Boiler. To shut down the Boiler safely do one of the following so the Boiler can go through a normal shut down sequence with post purge cycles that cool down the Heat Exchanger and purge the combustion chamber:

- Lower the Operating Set Point to it's lowest setting.
- Lower the set point of the external Primary System Control in use to it's lowest setting.
- Then turn the boiler off using the on/off switch on the boiler cabinet.

START UP PROCEDURE

1. Before starting the Boiler, read the Instruction Manual supplied with the Boiler. Ensure the water piping, supply gas line, boiler controls, and venting have all been installed per the Instruction Manual requirements. Do not perform a Start Up unless all installation requirements and instructions contained in the Instruction Manual that came with the Boiler have been followed and observed.
2. Ensure the Boot Tee vent fitting has been installed at the vent connection on the back of the Boiler.
3. Using a plastic Tee fitting and flexible tubing (see Tools Required on page 3) install the Tee fitting in-line with the Boiler's pressure switch sensing tube connected to the Manifold Pressure Sensing Port on the Manifold Gas Train. Connect a digital manometer to the branch connection on the Tee fitting with flexible tubing, see Figure 27 on page 37 and Figure 28 on page 38.
4. Turn off the supply gas to the Boiler upstream from the Boiler in the supply gas line. Remove the 1/8" NPT pipe plug from factory installed supply gas shutoff valve on the Boiler. Install a 1/8" barbed fitting adapter into the threaded opening on the shutoff valve body and connect a manometer to the barbed fitting using flexible tubing, see Figure 27 on page 37.
5. Purge all air from the supply gas line to the Boiler and ensure there are no gas leaks. Ensure all supply gas shutoff valves to and at the Boiler are open after purging is complete.
6. Record the static (gas not flowing) supply gas pressure to the Boiler using the manometer connected above. Ensure the static supply gas pressure is within the minimum and maximum supply gas pressure requirements given in the Instruction Manual that came with the Boiler. Adjust the supply gas pressure at the supply gas regulator as necessary.
7. Be certain that the system water piping, water system components and Boiler are filled with water. Ensure all air has been purged from the Boiler, any connected storage tank(s) and system water piping. Fully open the supply and return water valves to the Boiler. Fully close the bypass valve in the bypass line that is installed between the Boiler supply and return water lines. Ensure there are no water leaks.
8. Ensure the power supply meets the electrical requirements given in the Instruction Manual that came with the Boiler.
9. Ensure the Boiler **IS NOT** sharing power supply hot, neutral or ground wires or a circuit breaker with any other appliance.
10. Perform the Power Supply Test on page 33, correct any problems detected.
11. Ensure all Boiler Control Wiring is properly installed and securely connected. Check all control wiring to the Remote Temperature Probe, optional Quad Thermistor Probe and any external controls using the Boiler's Enable/Disable circuit, see Boiler Controls on page 6.
12. Verify proper operating sequence prior to Start Up. Close the Manifold Gas Shutoff Valve, see Figure 28 on page 38. Energize the branch circuit supplying power to the Boiler and turn the Boiler's on/off switch to the on position. Ensure the Operating Setpoint is set high enough to activate a heating cycle, see Operating Setpoint Adjustment on page 43. If an external control is using the Boiler’s Enable/Disable circuit ensure the external that control's contacts are closed, see Boiler Controls on page 6. If there is no external control using the Boiler’s Enable/Disable circuit ensure the two wires provided for this circuit are wire nutted together in the junction box on the back of the Boiler, see Figure 1 on page 6.

    The Boiler's Control System will attempt to start a heating cycle. The operating sequence should halt when the Control System fails to verify flame sensing current. The Control System should lock out and display the "Flame" error message on the LCD due to ignition failure. This operating sequence test verifies the Boiler Circulation Pump, Flow Switch, Igniter, Combustion Blower, Low Gas Pressure switch, and all three pressure switches (see Pressure Switches on page 18) are functioning properly.
13. Open the Manifold Gas Shutoff Valve, see Figure 28 on page 38.
14. Drill a hole large enough (7/16” to 3/8" typical) in one side of the Boot Tee vent fitting approximately 8" from the back panel of the Boiler for the combustion analyzer's sampling probe. Use a small scrap piece of AL29-4C stainless vent material and high temperature RTV sealant to seal the sampling hole when the start up procedure is completed.

15. Energize the branch circuit supplying power to the Boiler and turn the Boiler's on/off switch to the on position. Ensure the Operating Setpoint is set high enough to activate a heating cycle, see Operating Setpoint Adjustment on page 43. If an external control is using the Boiler's Enable/Disable circuit ensure the external that control's contacts are closed, see Boiler Controls on page 6. If there is no external control using the Boiler's Enable/Disable circuit ensure the two wires provided for this circuit are wire nutted together in the junction box on the back of the Boiler, see Figure 1 on page 6.

    Service Note

    If the Boiler fails to light off or is experiencing rough starting or rough operation, turn the Boiler's on/off switch to the off position, see Poor Combustion - Ignition Failure - Rough Start/Operation on page 46 to determine the cause and correct the problem.

16. Check the dynamic (gas is flowing) supply gas pressure again. Ensure the dynamic supply gas pressure is within the minimum and maximum supply gas pressure requirements given in the Instruction Manual that came with the Boiler. Adjust the supply gas pressure at the supply gas regulator as necessary.
17. Allow the Boiler to run for 15 minutes before performing combustion analysis. After 15 minutes of operation set the Modulate Mode to the Max Mode firing mode, see Modulate Mode Adjustment on page 34.
18. Insert the combustion analyzer sampling probe into the 7/16" hole previously drilled in the Boot Tee. Follow the manufacturer's instructions for the combustion analyzer being used to sample and record the CO (carbon monoxide) and CO2 (carbon dioxide) readings.
19. Compare the CO2 readings recorded to the High Fire CO2 parameters in Table 7 on page 36 below. If the CO2 readings recorded are not within the range given in Table 7 on page 36 adjust as follows:

    Remove the round blue plastic cap from the top of the Boiler's 120 VAC Gas Valve. Using a 3mm (7/64") hex wrench, turn the high fire adjustment screw under the cap counterclockwise to increase or clockwise to decrease gas flow until the desired CO2 level is reached, see Figure 28 on page 38. Increasing the gas flow will increase CO2 levels in the vent gases, decreasing gas flow will reduce CO2 levels. Reinstall blue cap when adjustments are complete. CO readings should be less than 200 ppm (parts per million).

    SERVICE NOTE:

    Adjust gas flow settings small increments (no more than 1/8 turn) and allow the combustion readings to stabilize for at least 3 minutes before making further adjustments. If required CO2 levels on start up form that came with the Boiler differ from levels in this manual adjust to levels shown on start up form.

TABLE 7

HIGH FIRE SETTINGS	
Natural Gas	8.5 - 11.0 % CO2 (CO < 200 ppm)
Propane Gas	9.5 - 12.0 % CO2 (CO < 200 ppm)

20. Set the Modulate Mode to the Min Mode firing mode, see Modulate Mode Adjustment on page 34. Allow the Boiler to run for 5 minutes and then record the CO2 and CO levels.
21. Compare the CO2 readings recorded to the Low Fire CO2 parameters in Table 8 below. If the CO2 readings recorded are not within the range given in Table 8 adjust as follows:

    Remove the small metal slotted cap near the outlet of the Boiler's 24 VAC gas valve. Using a TORX® T40 or a 5mm hex wrench turn the low fire adjustment screw under the cap clockwise to increase or counterclockwise to decrease gas flow until the desired CO2 level is reached, see Figure 28 on page 38. Increasing the gas flow will increase CO2 levels in the vent gases, decreasing gas flow will reduce CO2 levels. Reinstall the slotted cap when adjustments are complete. CO readings should be less than 200 ppm.

TABLE 8

LOW FIRE SETTINGS	
Natural Gas	7.5 - 9.5 % CO2 (CO < 200 ppm)
Propane Gas	9.5 - 12.0 % CO2 (CO < 200 ppm)

22. Set the Modulate Mode to the Max Mode firing mode again and recheck CO2 readings, fine tune the gas flow as necessary.

23. Set the Modulate Mode to the Min Mode firing mode again and recheck CO2 readings, fine tune the gas flow as necessary.
24. When gas flow adjustments are complete remove all test instruments and replace all plugs and caps.

Water Flow Setup

25. Set the Modulate Mode to the Max Mode firing mode again. Ensure the water supply (outlet) and return (inlet) water valves at the Boiler are fully open. Ensure the bypass valve in the bypass line that is installed between the Boiler supply and return water lines is fully closed, see Figure 33 on page 65. With the boiler firing at 100% in the Max Modulate Mode gradually throttle the Boiler's supply (outlet) valve towards the closed position until a 20°F to 30°F ΔT (Delta T) is achieved. ΔT (Delta T) can be viewed on the Control System's Temperatures Menu, see Control System Menus on page 44.
26. With the ΔT adjusted to 20°F to 30°F, slowly throttle open the bypass valve in the bypass line until the inlet water temperature is at least 120°F. The ΔT may change -when the bypass valve is throttled open, do not readjust the ΔT.

    SERVICE NOTES:

    The return (inlet) water valve must be left fully open at all times except when servicing the Boiler. Do not throttle the return water valve under any circumstances. Advise the end user/customer that the supply, return and bypass valve positions must stay in the positions set during start up. It may be advisable to remove the valve handles to prevent accidental changes.

    Advise the customer to keep a Boiler Temperature Log near the Boiler and record inlet, outlet and ΔT readings on a weekly basis. When the ΔT rises 5°F or more the customer should call a Qualified Service Agent to perform deliming maintenance to insure optimal efficiency and reduce wear on the Boiler, see Boiler Temperature Logs on page 69.
27. When all of the above procedures are complete return to the User Settings Menu and place the Modulate Mode back into Mod Mode. Adjust the Operating Set Point in the User Settings Menu to desired system temperature. Remove all test instruments and replace all plugs and caps.

SUPPLY GAS PRESSURE TEST

MANIFOLD GAS PRESSURE TEST

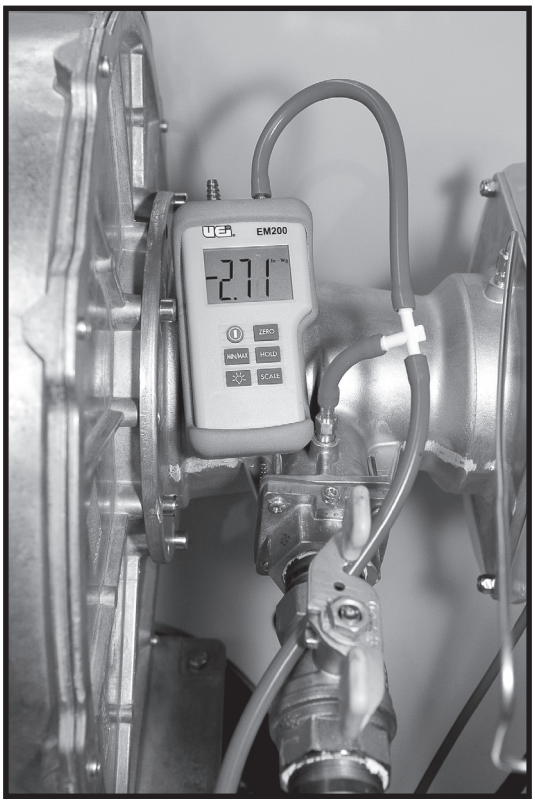


Figure 27

MANIFOLD GAS PRESSURE TEST

Using a plastic Tee fitting and flexible tubing (see Tools Required on page 3) install the Tee fitting in-line with the Boiler's pressure switch sensing tube connected to the Manifold Pressure Sensing Port on the Manifold Gas Train. Connect a digital manometer to the branch connection on the Tee fitting with flexible tubing, see Figure 27 on page 37 and Figure 28 below.

TABLE 9

MANIFOLD GAS PRESSURES		
	Max Mode - 100% firing	Min Mode - 25% Firing
Natural Gas	-1.5" W.C. to -3.0" W.C.	-0.10" W.C. to -0.20" W.C.
Propane Gas	-2.5" W.C. to -4.0" W.C.	-0.20" W.C. to -0.40" W.C.

1. Set the Modulate Mode to the Max Mode firing mode (see Modulate Mode Adjustment on page 34) and record the pressure reading at the maximum (100%) firing rate.
2. Set the Modulate Mode to the Min Mode firing mode (see Modulate Mode Adjustment on page 34) and record the pressure reading at the minimum (25%) firing rate.
3. Compare the readings to the parameters in Table 9 above for the correct fuel type and firing rate.

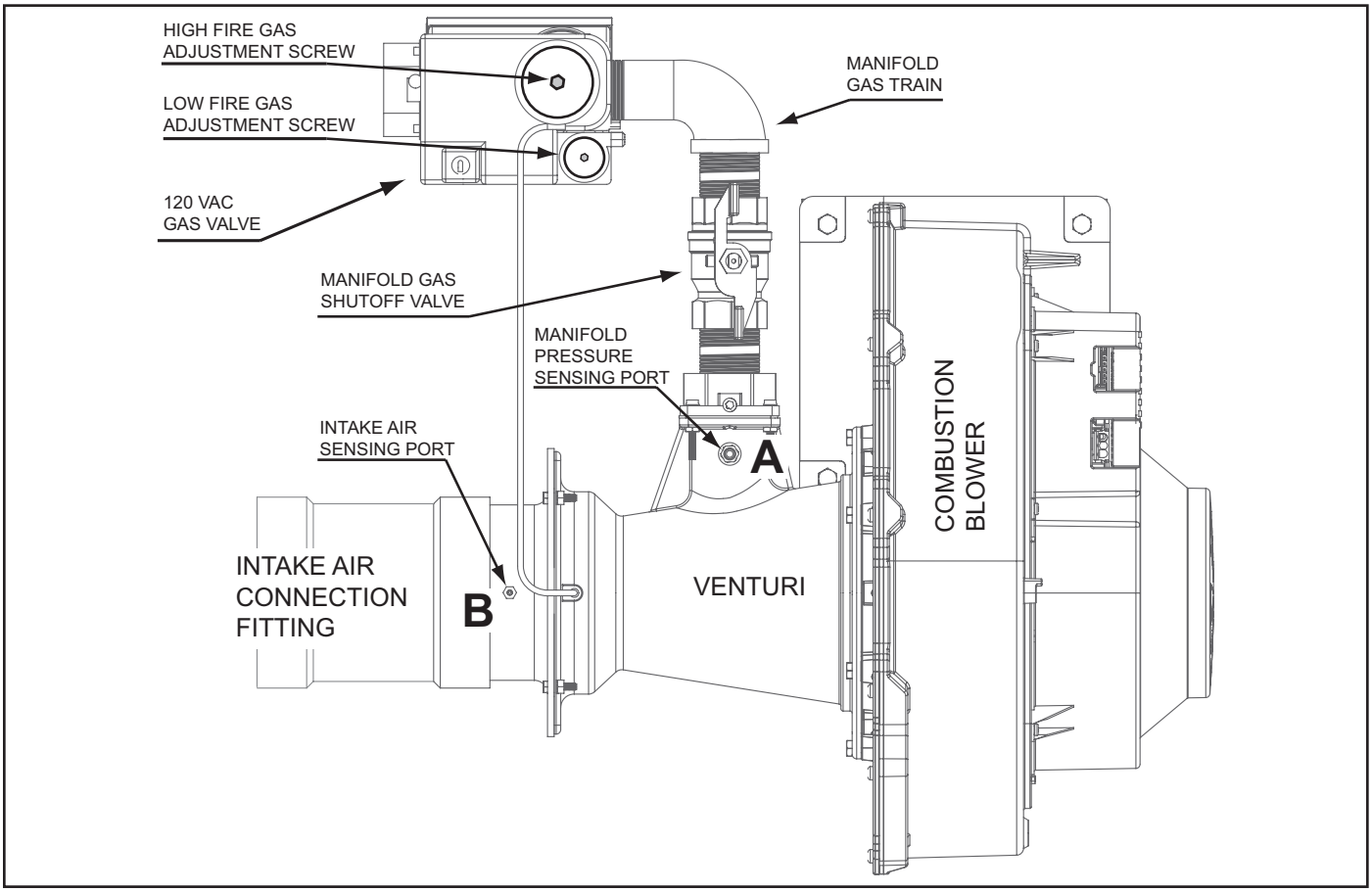


Figure 28

SERVICE NOTE: If the actual pressures observed during the test above are considerably different (higher pressures - closer to a positive pressure) closely inspect all fittings and flanges in the gas train between the outlet of the boiler's 120 VAC gas valve and the Venturi assembly. Reseal/repair any leaking connections - replace any worn or damaged gaskets.

Disassemble the Venturi from the inlet connection at the Combustion Blower (round flange) and the intake air connection (square flange) - ensure the large “O” ring gaskets are not damaged and seating properly.

Closely inspect the cone shaped restrictor inside the Venturi for any signs of damage or wear. If the restrictor is missing, damaged, or visibly worn - replace the Venturi.

CONTROL SYSTEM OPERATION

EMC 5000 MODULATION CONTROL

VF Boilers are equipped with the EMC 5000 Modulating Control System. EMC 5000 is an electronic boiler Control System developed by A. O. Smith. EMC stands for Energy Management Control. The Control System modulates the Boiler's firing rate between 25% and 100%; a four-to-one turn down rate.

This section of the Service Manual will cover Control System navigation and operation. The Control System includes three main electronic components: a UIM (User Interface Module), a MCB (Modulation Control Board), and a PDB (Power Distribution Board).

See MCB - Modulation Control Board on page 19, PDB - Power Distribution Board on page 28 and UIM - User Interface Module on page 40.

CONTROL SYSTEM FEATURES:

- **EMI / RFI filtering** - EMI = Electro Magnetic Interference, RFI = Radio Frequency Interference. These are two forms of electrical line noise that can cause erratic operation in electronic devices. The electrical noise filtering built into all Control System circuit boards helps eliminate erratic operation caused by EMI/RFI.
- **Help Screens** - text based operational information to help the user understand how to change settings and navigate Control System menus.
- **Self Diagnostics** - text based diagnostic information (error and fault messages) on board to help service technicians quickly and accurately identify and correct operational problems.
- **Error History** - the Control System retains a 9 event history of error messages with a time stamp. Helps service technicians diagnose load and/or environmental conditions that may be contributing to operational problems or Control System lock out conditions.
- **Short Cycle Protection** - if the Boiler logs more than 30 heating cycles in one hour the control enters a short cycle prevention mode. The Boiler will continue to operate in this mode. The UIM will display and log a “Short Cycle Cond” error message with the yellow Standby system status LED flashing. The Control System will add a 180 second delay before activating subsequent heating cycles during this operating mode.

  The short cycle protection mode can be ended (reset) by touching the Select button on the UIM while the error message is displayed.
- **Temperature Probe Filtering** - the Control System filters data from the inlet, outlet, and remote Tank/ Loop temperature probes for 4 seconds before activating a heating cycle. This filtering helps prevent short cycling caused by momentary fluctuations in temperature.
- **Pressure/Flow Switch Filtering** - the Control System constantly monitors the state of various switches such as the blower prover, blocked flue and low gas pressure switches. Input data from these switches is filtered (de-bounced) for 4 to 6 seconds. This desensitizes the input signal and prevents nuisance error/fault conditions due to momentary fluctuations caused by wind gusts or blower speed changes.
- **iCOMM™ Compatible** - VF Boilers are compatible with the A. O. Smith iCOMM™ remote monitoring system. The iCOMM™ system hardware and monitoring service is purchased separately. The iCOMM™ remote monitoring system allows users to monitor critical operational, diagnostic and energy usage data from a secure web site.

  The iCOMM™ system can automatically notify selected personnel via email and/or cellular phone text messages if operational problems or user defined Alert Conditions, such as low system water temperature, occur.

  iCOMM™ system is also compatible with BACnet compliant supervisory controls and building management systems. For more information call 888 928-3702.

CONTROL SYSTEM NAVIGATION

UIM - USER INTERFACE MODULE

The UIM is an assembly that consists of several electronic components. The circuit board in the assembly is the UIB (User Interface Board) which includes a communications port. The UIB relays user input and data to and from the MCB (Modulation Control Board). The UIM also includes a LCD, three System Status LED lights, and five User Input Buttons. The LCD displays all operational information and diagnostic messages.

LEDs (Light Emitting Diode)	• Three “System Status” LED lights: Service, Standby, Running. Located to the right of the LCD. • Firing Rate Status indicator - located in the lower right portion of the UIM. There are four LED lights behind a green (gradient) translucent cover which indicate the approximate firing rate between 25% and 100%.
LCD (Liquid Crystal Display)	• Displays 4 lines with up to 20 characters per line of alphanumeric operational and diagnostic information. • There are 10 Control System menus - Main Menu, Temperatures, System Status, Control States, User Settings, Config Settings, Log & System Info, Existing Error, Error History, and Reload Defaults, see Control System Menus on page 44. • Displays alphanumeric operational and diagnostic information.
User Input Buttons	• 5 buttons for Control System navigation and user input: Select, Menu, Help, Up and Down.
Settings/Memory	• Non volatile memory; once new user settings are confirmed (with the Select button) they are immediately stored in the Control System memory. Current user settings are held in the Control System memory indefinitely until they are changed.

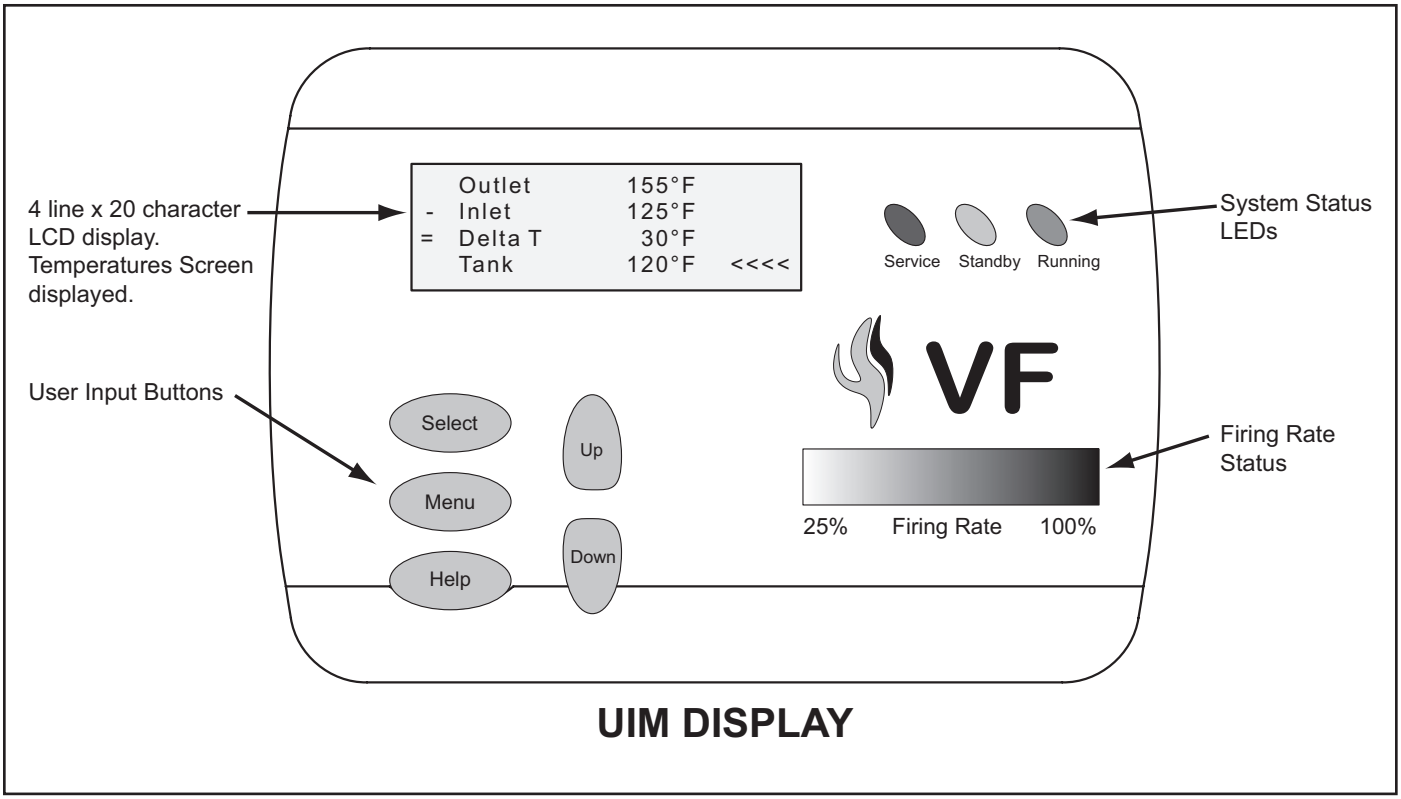


Figure 29

STATUS LIGHTS

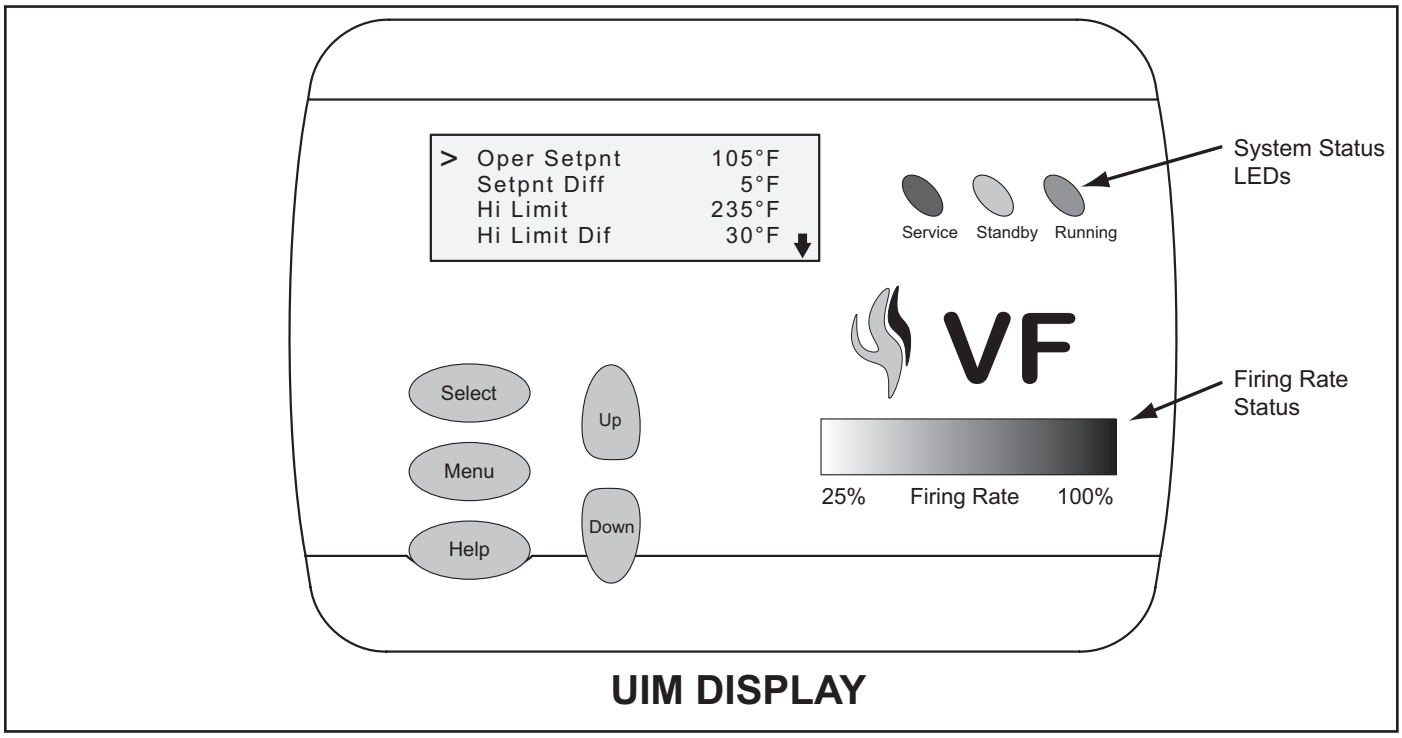
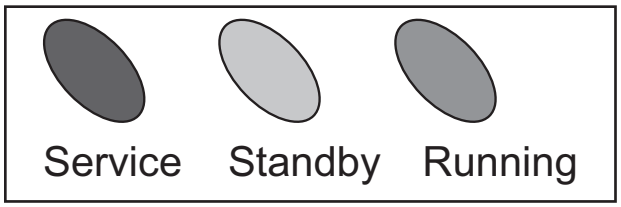


Figure 30

SYSTEM STATUS LED LIGHTS



The three “System Status” LED lights on the upper right portion of the UIM convey current operational and diagnostic information.

The red Service LED will be continuously illuminated for soft lock-outs and flashing on and off for hard lockouts.

Soft Lock Outs will automatically reset after the condition that caused the error has been corrected or a factory programmed time period of 20 minutes has elapsed. Soft lock-outs can also be reset with the Select button while the error message is displayed on the LCD screen.

Hard Lock Outs can be reset with the Select button while the error message is displayed on the LCD screen. Hard lock outs can also be reset by cycling power to the Boiler off and on again.

The yellow Standby LED is illuminated whenever the system set point has been satisfied.

The green Running LED is illuminated continuously whenever a call for heat is active.

FIRING RATE STATUS

The Firing Rate Status indicator shows the current firing rate of the Boiler between 25% and 100%.

The Firing Rate Status indicator will not illuminate unless flame is proven by one of the two Flame Sensors; high fire sensor/low fire sensor, see Figure 5 on page 11.

There are four LED lights behind a gradient translucent cover which indicate the firing rate. Each LED light indicates approximately 25% of the total firing rate. IE: three LEDs illuminated would indicate a firing rate of approximately 75%.

USER INPUT BUTTONS

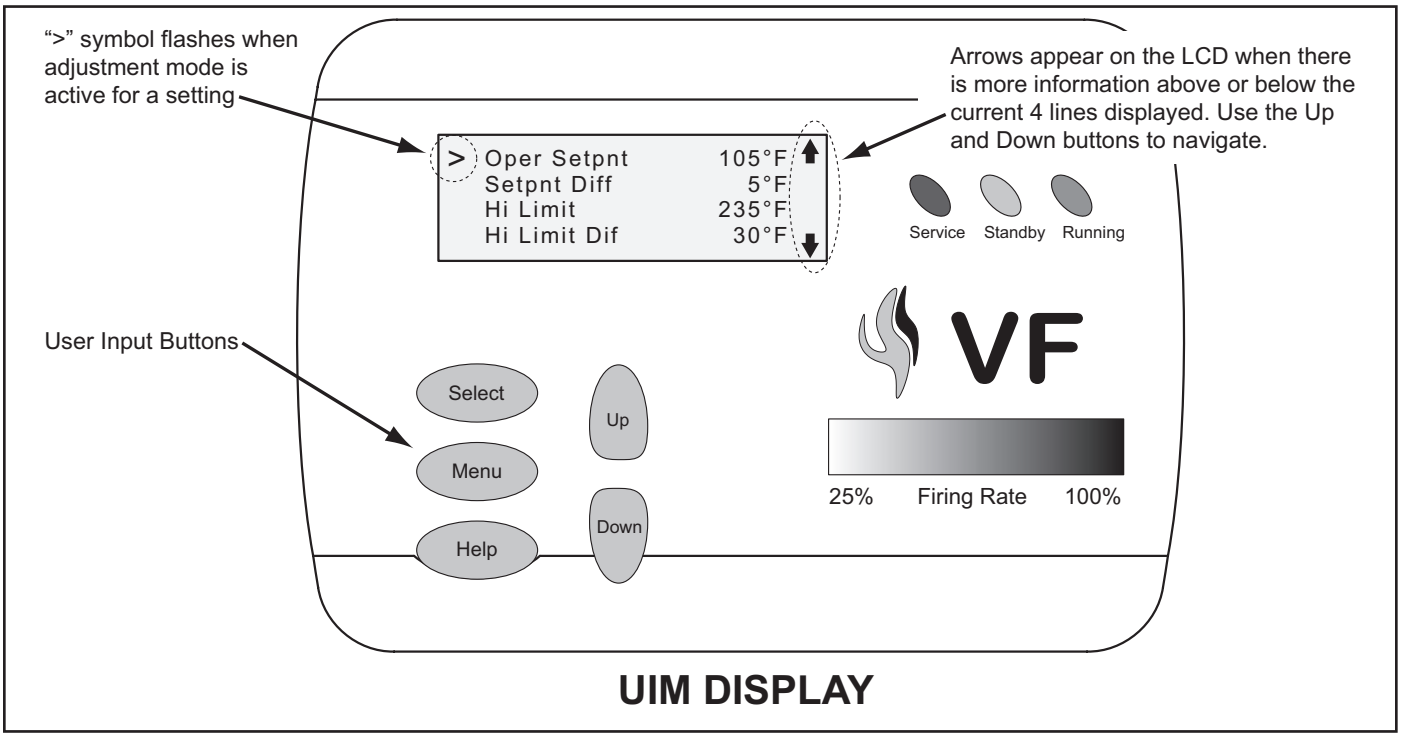
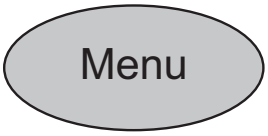


Figure 31

SELECT BUTTON

- Enter Control System menus.
- Activate the adjustment mode for various user settings. The [**>**] symbol will be flashing slowly to the left of the user setting when the adjustment mode is active for that setting, see Figure 31.
- Confirm and store new values and settings in memory.
- Reset the Control System when in a lock out condition.

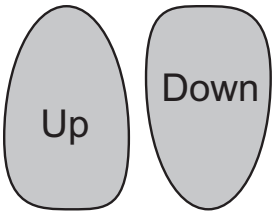


MENU BUTTON

- Press once to display the Main Menu showing all Control System menus.
- Abort or cancel new values and settings, returning to the last saved value.

HELP BUTTON

- Press once to display helpful information about the current menu. Press a second time to return to the previous screen.
- Press when the Main Menu is displayed to provide general information on Control System navigation and changing user settings.



UP AND DOWN BUTTONS

- Scroll or navigate up and down lists of Control System menus and menu items. When the current menu contains more than four lines of text, Up and Down arrows will appear on the right side of the LCD screen indicating more information is available off screen, see Figure 31.
- Change values when the adjustment mode for a setting has been activated. The Select button must be pressed once more to confirm and store the new value in memory.

ADJUSTING USER SETTINGS

OPERATING SETPOINT ADJUSTMENT

The Operating Setpoint is the most commonly adjusted user setting and represents the temperature the Control System will regulate water temperature at in a storage tank or hydronic heating loop. The Operating Setpoint is abbreviated "Oper Setpnt" in the User Settings Menu.

Figure 32 and the instructions below show how to navigate to the User Settings Menu and change the Operating Setpoint. See Figure 31 on page 42 to locate the User Input Buttons mentioned in these instructions. Use this same procedure to adjust any of the Control System user settings.

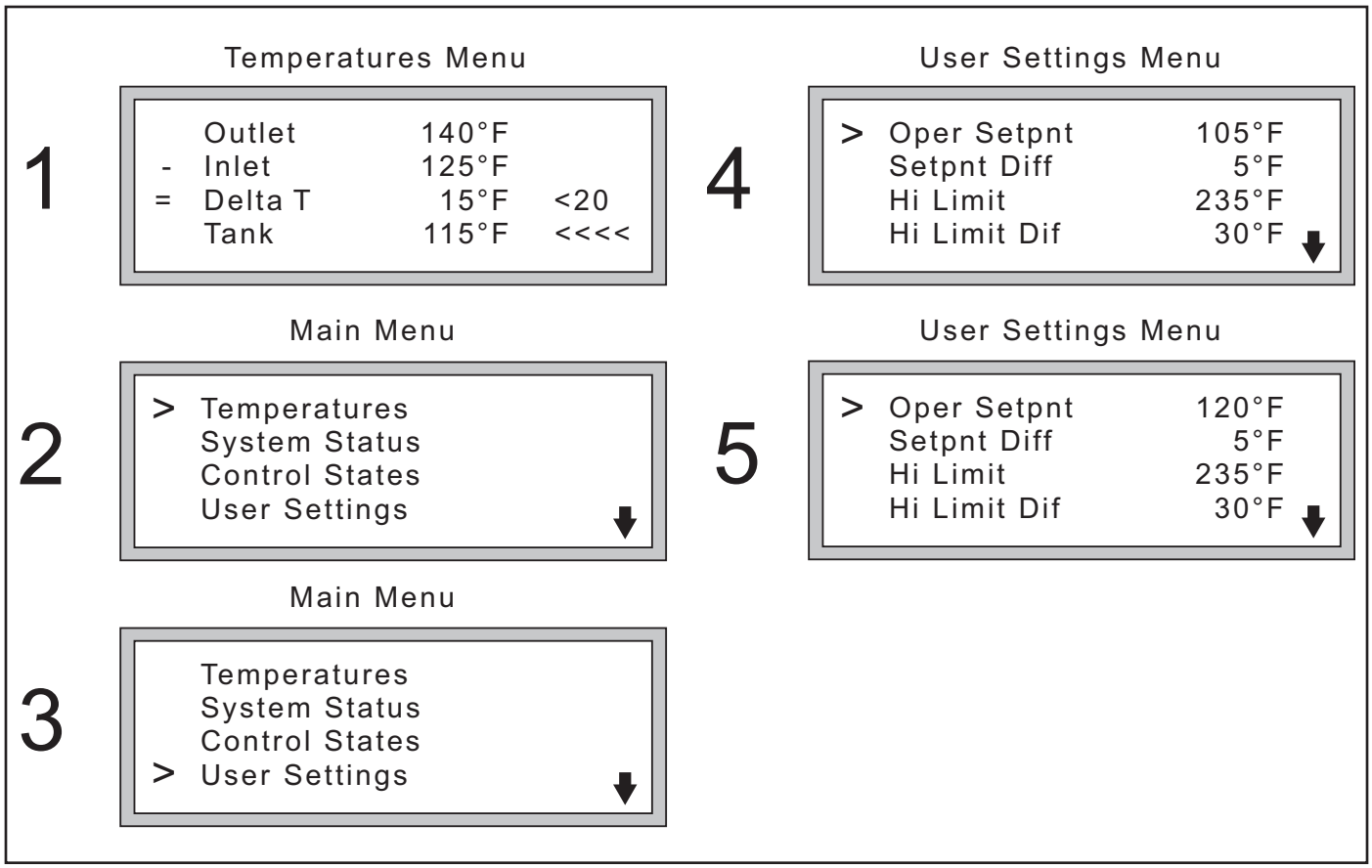


Figure 32

Operating Setpoint Adjustment

Refer to Figure 32 for these instructions.

1. From the default Temperatures Menu touch the User Input Button labeled "Menu" one time. This will display the Main Menu, see Control System Menus on page 44.
2. From the Main Menu touch the "Down" User Input Button 3 times until the ">" symbol aligns with the "User Settings" menu item.
3. With the ">" symbol aligned with User Settings, touch the User Input Button labeled "Select" to enter the User Settings Menu.
4. With the ">" symbol aligned with the "Oper Setpnt" menu item touch the User Input Button labeled "Select" one time to activate the adjustment mode for this user setting. The ">" symbol will start to flash on and off slowly to confirm the adjustment mode has been activated for this setting.
5. Using the Up and Down User Input Buttons raise or lower the Operating Setpoint to the desired temperature. Touch the User Input Button labeled "Select" to confirm and save the new setting in the Control System memory or touch the User Input Button labeled "Menu" to cancel the new setting and return to the last saved setting.

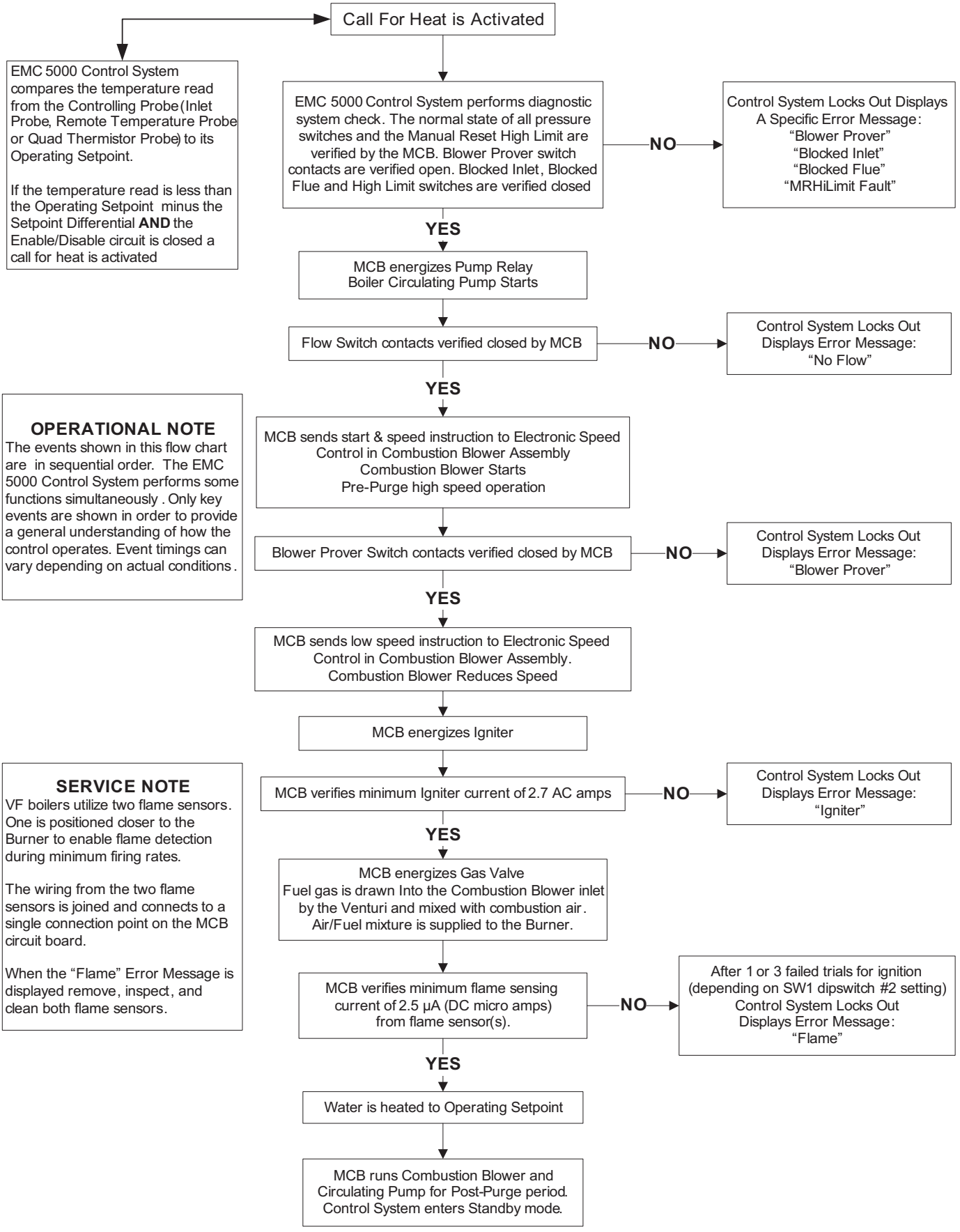
CONTROL SYSTEM MENUS

At the top center of the UIM panel is the display LCD. This LCD is used to provide information to the user through various Control System Menus. There are 10 Control System Menus, see Table 10 below. Helpful context sensitive information can be displayed at any time by touching the “Help” button. Touching the help button once more returns the user to the previous screen.

TABLE 10

MENU	DESCRIPTION
Main Menu	Displayed when the “Menu” button is touched. This menu is the selection point for all other Control System menus. There are no adjustable user settings in this menu.
Temperatures	Displays the temperatures sensed from the Outlet and Inlet Temperature Probes, see page 15. Temperatures sensed from the Remote Temperature Probe or an optional Quad Thermistor Probe are also displayed in the Temperatures menu as "Tank", see pages 15, 16 and Figure 32 on page 43. This menu also displays the calculated temperature rise (Outlet minus Inlet) through the Boiler, also referred to as the Delta T and expressed as ΔT. The Temperatures Menu is the default menu. The Control System will revert to the Temperatures menu when there is no user input for approximately 90 seconds. There are no adjustable user settings in this menu.
System Status	This menu is used to view the status of various boiler functions and components such as pressure switches, Igniter power, minimum Igniter amps, the Flow Switch, the automatic and manual reset high temperature limits (Hi Limit & MRHiLimit), the Boiler Circulation Pump, optional LWCO (Low Water Cut Off), the Enable/Disable circuit and minimum flame sensing current. An asterisk (*) is displayed next to a System Status menu item when the status of that item is “True” (the description is fulfilled) or on/energized. For example; if water is flowing, as detected by the Flow Switch, an asterisk (*) will appear in front of the Flow label (IE: *Flow). If the Control System has energized the Boiler Circulation Pump an asterisk will appear next to the "Pump" menu item in the System Status Menu. The status for the functions and components displayed in the System Status Menu is in real time. This menu is very useful when performing diagnostic troubleshooting procedures. There are no adjustable user settings in this menu.
Control States	The current operating state of the Control System is displayed in this menu along with the Combustion Blower speed in rpm (revolutions per minute). Combustion Blower rpm is displayed in real time. There are no adjustable user settings in this menu.
User Settings	This menu is used to enter values for various user settings such as; the Operating Setpoint abbreviated Oper Setpnt, the Hi Limit (automatic high limit) and the pump post circulate time. See Adjusting User Settings on page 43.
Config Settings	Displays the status of the SW1 and SW2 dip switches. See MCB - Section D on page 23 and MCB - Section G on page 26. There are no adjustable user settings in this menu.
Log & System Info	This menu displays the following operational information: Elapsed hours of operation (Total time system has been powered up), number of running minutes (total minutes the system has been in the run mode), number of heating cycles, kBtu rating of the Boiler and the software revision of the MCB and Config Key. There are no adjustable user settings in this menu.
Existing Error	Displays the current error message the Control System has detected, plus a timestamp of when the error occurred. The actual time the error occurred can be determined by subtracting the error message timestamp from the Elapsed hours of operation shown in the Log & System Info menu. This can be very helpful when trying to determine if the error is related to environmental or load conditions. There are no adjustable user settings in this menu.
Error History	This menu displays a list of the last 9 error messages (with timestamps) that have occurred. The last error message to occur is displayed first. The oldest error message, number 9, is deleted when a new error message occurs. There are no adjustable user settings in this menu.
Reload Defaults	From this menu the user can restore the factory default values for all adjustable user settings.

SEQUENCE OF OPERATION



TROUBLESHOOTING

POOR COMBUSTION - IGNITION FAILURE - ROUGH START/OPERATION

If the high and/or low fire CO2 combustion readings are not in accordance with Table 7 and Table 8 on page 36, or the CO readings are high, or if the boiler is experiencing ignition failure or rough starting/operation perform the following procedures:

VERIFY CORRECT CONFIG KEY IS INSTALLED

1. Ensure the Boiler has the correct Config Key installed, see Config Key on page 13 for instructions on how to verify the correct Config Key is installed. If it is determined the wrong Config Key is installed call the toll free support phone number on the back cover of this manual for further assistance.

ADEQUATE COMBUSTION AIR - PROPER VENTING

2. **Combustion Air:** carefully review the requirements for combustion and ventilation air in the Instruction Manual that came with the Boiler. Ensure there is an adequate supply of fresh air for combustion and the boiler is vented properly. Do not overlook this step. Lack of combustion air and improper venting is often the root cause for poor combustion, ignition failure and Control System lock out. Ensure all air requirements listed in the Instruction Manual that came with the boiler have been observed.
3. **Direct Vent Installations:** If the boiler is using outdoor air for combustion (direct vent) ensure the intake air or the vent pipe is not restricted and neither has exceeded the maximum equivalent feet or maximum number of elbow limitations given in the Instruction Manual that came with the boiler. Ensure the required Boot Tee fitting has been installed at the Boiler's vent connection. Ensure the specified (check parts list) vent and intake air termination fittings have been installed. The factory supplied terminations and Boot Tee fitting are critical, failure to install required vent system components will result in operation problems.

   If the boiler is in an equipment room with a door to the outdoors, temporarily disconnect the intake air pipe and prop open the equipment room door. Take combustion readings again to see if this corrects the problem. If the combustion readings improve with the intake air pipe disconnected, the intake air pipe is either restricted or has too many equivalent feet or too many elbows installed.
4. **Conventional Vent Installations:** If the boiler is using room air for combustion (conventional vent) ensure the vent pipe is not restricted and has not exceeded the maximum equivalent feet or maximum number of elbow limitations given in the Instruction Manual that came with the boiler. Ensure the required Boot Tee fitting has been installed at the Boiler's vent connection. Ensure the specified (check parts list) vent termination fitting has been installed. The required termination and Boot Tee fitting are critical, failure to install required vent system components will result in operation problems.

   Ensure the fresh air openings in the equipment room are adequately sized for the combined input Btu/hr rating of all conventionally vented fuel burning appliances in the room. If the boiler is in an equipment room with a door to the outdoors - prop open the equipment room door. Take combustion readings again to see if this corrects the problem. If the combustion readings improve with the door open the fresh air openings may be undersized, see the Air Requirements in the Instruction Manual to correct the problem.

Service Note

If the Instruction Manual that came with the boiler is not on hand or there is any questions regarding the Air Requirements or Venting instructions; call the toll free support phone number on the back cover of this manual for further assistance. Costs to correct installation errors are not covered under the limited warranty.

VENT GAS RECIRCULATION

Vent gases recirculating from the vent termination into the intake air termination on direct vent installations is a serious installation problem that **MUST BE** corrected. It will cause poor combustion, high Carbon Monoxide (CO) levels, delayed ignition, rough starting/operation and ignition failure. Costs to correct installation errors are not covered under the limited warranty.

5. Vent and intake air terminations on direct vent installations may be allowing the recirculation of vent gases to the intake air pipe. Ensure both terminations on direct vent installations have been installed with adequate clearances. See the Instruction Manual that came with the boiler for venting instructions and vent/intake air termination clearance requirements.

RESTORE GAS FLOW SETTINGS TO DEFAULT

Each VF Boiler is fired and the optimal combustion set before leaving the factory. The High and Low Fire gas flow adjustment screws on the 120 VAC Gas Valve have been set to maximize the boilers performance. When performing the on site Start-up, gas flow can be improperly adjusted to the point the boiler will not light. This may require the valve to be reset to a minimum gas flow (default) setting that will allow the unit to safely fire and perform the necessary adjustments outlined in the Start-up procedure to ensure proper combustion and performance. Follow these steps to reset the gas flow settings to the minimum gas flow (default) settings:

6. With the boiler turned off. Use the correct size TORX® and/or Allen wrench to adjust the high fire and low fire adjustment screws on the 120 VAC Gas Valve. Turn the High Fire adjustment screw clockwise and the Low Fire adjustment screw counter-clockwise until they will not turn any more. This will close both gas flow adjustment screws, see Figure 28 on page 38. Do not overtighten or use excessive force, turn the adjustment screws until they stop with minimal force applied.
7. With both adjustment screws closed, turn the High Fire adjustment screw counter-clockwise 2 1/2 turns and the Low Fire adjustment screw clockwise 2 1/2 turns. The gas flow settings are now reset to the minimum gas flow (default) setting.
8. The boiler should light off with these minimum gas flow (default) settings. Follow the Start Up Procedure on page 35 to make final gas flow adjustments and ensure proper combustion and performance. If the boiler will not light off with the gas flow adjustment screws reset as described above call the toll free support phone number on the back cover of this manual for further assistance.

FIRING RATE - MODULATION PERFORMANCE

The firing rate on VF boilers is modulated or controlled by blower speed, see Modulating Fire Operation on page 10, Venturi & Gas Train on page 12 and Combustion Blower Speed Data on page 14. Ensure the correct Config Key is installed for the input Btu/hr rating and fuel type of the boiler you are working on, see Config Key on page 13. Follow these steps to ensure the firing rate and modulation performance are correct:

9. Verify the blower speed is acceptable during the following three operating states:
   - Igniter warm up period.
   - Min Mode
   - Max Mode

   Blower speed can be viewed in real time in the Control States menu, see Control System Navigation on page 40 and Combustion Blower Speed Data on page 14.
10. Ensure the 5 pin MCB Speed Instruction plug is fully inserted and making good contact in the 5 pin socket on the Combustion Blower Assembly, see Figure 4 on page 10.
11. Ensure the wiring harness plug to the J24 socket on the MCB is fully inserted and making good contact, see MCB - Section H on page 27.

BURNER INSPECTION

The stainless steel radial fire Burner used in VF Boilers can trap debris drawn into the combustion air intake. This can cause poor combustion, rough starting/operation and ignition failure. When cutting the intake air pipe sections during installation, carefully remove all plastic debris left on the ends of each pipe section before installation to avoid this problem.

12. Turn off the power supply. Disconnect the Venturi from the Combustion Blower, see Figure 6 on page 12.
13. Unplug the 3 pin and 5 pin plugs to the Combustion Blower assembly, see Figure 4 on page 10.
14. Remove the Combustion Blower and Blower Adapter to access the Burner, see Figure 5 on page 11.
15. Remove the Burner and inspect the burner for any signs of damage or debris inside. If the burner is damaged or contaminated with debris - replace the burner. Check all gaskets in the burner/blower assembly for wear or damage. Replace any worn or damaged gaskets.

Service Note

If the boiler is still experiencing poor combustion, rough starting/operating or ignition failure after all the steps in this section have been performed call the toll free support phone number on the back cover of this manual for further assistance.

ERROR MESSAGES

The EMC 5000 Modulation Control System performs exhaustive self diagnostics and displays detected fault conditions on the UIM (page 40) as Error Messages. Troubleshooting procedures for the most common Error Messages are covered in this Service Manual.

The first column in the Error Message Tables that follow will show the actual condition or Error Message as displayed on the UIM's LCD screen along with an explanation of the Error Message. Where applicable, a list of the most common causes is given in the first column. The second column details things to check/repair and associated diagnostic procedures.

SYSTEM STATUS MENU

The System Status menu can be used to view the status of various components/switches such as the 120 VAC Gas Valve, Flame Sensors, Pressure and Flow Switches. An asterisk (*) is displayed next to a menu item when the status is true or on, the asterisk is not displayed when the status of a menu item is false or off. Press the Menu Button on the UIM to access the Main Menu. Navigate to the System Status menu using the Up and Down Buttons on the UIM until the > symbol is adjacent to System Status in the Main Menu list and press the Select Button to enter the System Status menu. Using the information here along with the Sequence of Operation (see page 45) is very helpful when troubleshooting. IE; if water flow is detected by the Flow Switch (switch contacts are closed) an asterisk (*) will appear in front of the Flow menu item; *Flow.

THINGS TO CHECK BEFORE SERVICING

- Check the SW1 and SW2 dipswitches to ensure they are properly configured for the Boiler being serviced. Ensure the dipswitch settings are not enabling optional components such as a High Gas Pressure Switch, LWCO (Low Water Cut Off) or Power Accessories that are not installed. This can lead to false Error Messages and Control System lock outs, see MCB - Section D on page 23.
- Using the Instruction Manual that came with the Boiler as reference, verify the water piping, gas line, venting, power supply, and boiler controls are all properly installed, see Boiler Controls on page 6.
- Ensure the Config Key is the correct key for the Btu/hr input and fuel type of the Boiler being serviced, see Config Key on page 13.
- Ensure 120 VAC is supplied to the Boiler and that the polarity is correct per the electrical requirements in the Instruction Manual that came with the Boiler, see Figure 1 on page 6.
- Ensure the supply gas pressure to the Boiler is within the minimum and maximum pressures required in the Instruction Manual that came with the Boiler.

RESETTING CONTROL SYSTEM LOCK OUTS

Reset the EMC 5000 Modulation Control System by touching the Select button while the Current Error is displayed on the UIM's LCD screen, see Table 10 on page 44 for a list of Control System menus. Cycling power off and then on again will also reset most lock out conditions. Keep in mind if the problem that caused the lock out/Error Message is not corrected, the Control System will continue to lock out.

IMPORTANT SERVICE REMINDER

- When performing any troubleshooting step outlined in this Service Manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to and from a given component before replacing any electrical part or component.
- Ensure wires were stripped before being crimped in a wire connector, ensure wires are crimped tightly in their connectors, ensure connection pins in sockets and plugs are not damaged or worn, ensure plugs and sockets are mating properly and providing good contact.

Failure to perform these critical steps or to perform these steps thoroughly often results in needless down time, unnecessary parts replacement, and customer dissatisfaction.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
LCD Display Is Blank The LCD on the UIM is not showing any data. Possible causes for this include: • On/Off switch is turned off. • Tripped breaker - blown fuses. • 120 VAC power supply problems. • 24 VAC power supply problems. • Defective transformer. • Wiring or plug/socket connection problems. • UIM communication cable defective. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	• Ensure the Boiler's on/off switch is in the "on" position and is working properly and supplying 120 VAC to the on/off power relay coil - replace switch if defective. • Ensure the on/off power relay contacts are closed, see Figure 10 on page 17. Check for 120 VAC between terminals 8 and 9 on the PDB's TB1 terminal strip - replace relay if defective. • Ensure the circuit breaker/fuses is supplying power to the Boiler. • Ensure 7.5 amp fuse on MCB is not blown/missing - replace fuse, see page 20. • Check communication cable connections between the UIM and the MCB's Internal Comm Ports. Plug the UIM communication cable into the other Internal Comm port on the MCB, see page 25. Ensure the communication cable **IS NOT** plugged into one of the External Comm Ports. • Turn off power to the Boiler and install a new communication cable (standard Cat 5/6 network cable) between the UIM and the MCB's Internal Comm Port, see page 25. • Closely inspect communication ports on MCB and UIM for damage or wear. • Ensure 120 VAC power is properly connected in the junction box on the back of the Boiler. • Ensure 120 VAC is supplied to TB1 terminals 8 and 9 on the PDB. Hot wire to terminal 8, neutral wire to terminal 9, see page 29. • Ensure F3 fuse on the PDB is not blown/missing - replace fuse, see page 30. • Check for 120 VAC to transformer at the primary winding terminals on the transformer. • Check for 120 VAC at the PDB J1 Socket pins 3 and 6 that supply power to the transformer, see page 31. • Check wiring between PDB J1 Socket pins 3 and 6 and the primary winding on the transformer - repair/ replace any disconnected or damaged wiring. • Check for 24 VAC output at the transformer secondary winding terminals - if 24 VAC is not present AND the checks above were performed and the results were successful - replace the transformer. Check all primary and secondary transformer wiring for shorts before powering up the new transformer. • Check for 24 VAC between pins 1 & 2 and between pins 4 & 5 of the J1 Socket on the PDB, see page 31. Perform this test with the wiring harness plugged into the J1 Socket. • Ensure the pins in the J1 Socket/Plug on the PDB are in good condition and making good contact, see page 31. Repair or replace any parts that are worn, damaged, or failing to make a good connection. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
Display Fail Communication between the MCB and UIM has been interrupted - the MCB is unable to communicate with the UIM. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	• Plug UIM Comm cable into the other Internal Comm port on the MCB, see page 25. • Check communication cable to the UIM. Turn off power and Install a new/different communication cable (standard Cat 5 network cable). • Closely inspect communication ports on MCB and UIM for damage or wear. • Turn off power to the Boiler and install a new communication cable (standard Cat 5/6 network cable) between the UIM and the MCB's Internal Comm Port, see page 25. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.
No Config Key The MCB does not recognize the presence of a Config Key at MCB Socket J23. The Config Key contains model specific (Btu/hr & fuel type) blower speed programing data. This data is written to the MCB's internal memory at power up. The MCB then uses this data to modulate blower speed during various operating states, see Config Key on page 13. If this key is not plugged into the J23 Socket on the MCB circuit board the EMC 5000 Modulation Control System will declare a fault condition and display this Error Message on the UIM's LCD display.	• Ensure the Config Key is present and securely plugged into the J23 Socket on the MCB circuit board, see page 27. • Closely inspect Config Key plug pins - if damaged replace the Config Key for the correct Btu/hr model and fuel type, see page 27. Call the toll free support phone number on the back cover of this manual for further assistance. • Closely inspect the pins in the J23 Socket on the MCB for signs of wear or damage, see page 27. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.
Config Key CRC Data read from the Config Key by the MCB was not properly confirmed at power up. The Config Key contains model specific (Btu/hr & fuel type) blower speed programing data. This data is written to the MCB's internal memory at power up. The MCB then uses this data to modulate blower speed during various operating states, see Config Key on page 13.	• Ensure the Config Key is securely plugged into the J23 Socket on the MCB circuit board, see page 27. • Turn power off to the Boiler for 1 minute and then turn power back on. Press the Select button on the UIM to clear any error messages. This will provide the MCB a second attempt to read and store data from the Config Key. • Closely inspect Config Key plug pins - if damaged replace the Config Key for the correct Btu/hr model and fuel type, see page 27. Call the toll free support phone number on the back cover of this manual for further assistance. • Closely inspect the pins in the J23 Socket on the MCB for signs of wear or damage, see page 27. • Install a new Config Key for the correct Btu/hr model and fuel type if this error message continues. Call the toll free support phone number on the back cover of this manual for further assistance. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
Config Key Part The MCB has detected the Config Key is defective. The Config Key contains model specific (Btu/hr & fuel type) blower speed programing data. This data is written to the MCB's internal memory at power up. The MCB then uses this data to modulate blower speed during various operating states, see Config Key on page 13. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	• Turn power off to the Boiler for 1 minute and then turn power back on. Press the Select button on the UIM to clear any error messages. This will provide the MCB a second attempt to read and store data from the Config Key. • Install a new Config Key for the correct Btu/hr model and fuel type if this error message continues. Call the toll free support phone number on the back cover of this manual for further assistance. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.
Low AC Voltage The Control System has detected the power supply polarity is reversed or the line voltage to boiler is less than 90 VAC.	• Ensure power supply polarity is not reversed and boiler is properly grounded, see Figure 1 on page 6. • Perform the Power Test Procedure - correct any problems indicated by test, see page 33. • Check incoming power supply, wiring, and all line voltage connections on the Boiler and at the breaker or disconnect switch - repair/restore the 120 VAC power supply to the Boiler. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.
Low 24 VAC The Control System has detected voltage from transformer is less than 18 VAC.	• Check 120 VAC to transformer. Check for 120 VAC between pins 3 & 6 of the J1 Socket on the PDB, see page 31. Perform this test with the wiring harness plugged into the J1 Socket. • Ensure transformer is rated at 100 VA - replace the transformer if rating is less than 100 VA. • Turn off power to Boiler; temporarily disconnect load wiring from secondary winding on transformer. Turn power back on and check voltage at secondary coil - if secondary (24 VAC) voltage remains below 18 VAC - replace transformer. Check all primary and secondary transformer wiring for shorts before powering up the new transformer. • Check all 24 VAC wiring for worn/damaged connections or wires - replace/repair as necessary. • Replace the transformer. Check all primary and secondary transformer wiring for shorts before powering up the new transformer. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
Low Water The Control System has detected that water is not being sensed by the optional LWCO (Low Water Cut Off) device sensor. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	• Ensure there is water in the lines/boiler. • Remove and clean LWCO sensor. The LWCO sensor is located inside the upper compartment of the Boiler threaded into the upper head of the Heat Exchanger. One red wire leads from the LWCO Circuit Board on the Control Panel, see page 17. • If the SW1 #6 dipswitch is configured for LWCO present when the optional control is not installed the Control System will display a false a Low Water error message. If there **IS NOT** a LWCO installed on the Boiler ensure the SW1 dipswitch is set to the off position, see page 23. Power to the Boiler must be cycled off and on again for the configuration change to take effect. **Service Note:** SW1 dipswitch settings can be confirmed in the Config Settings menu, see Control System Navigation on page 40 and Control System Menus on page 44. • Check all wiring, plugs, and sockets between the J4 Socket on the MCB board and the LWCO circuit board. Ensure wiring is not pinched or cut, ensure all sockets and plug connections are mating properly and providing good contact - repair/replace any damaged or worn wiring or parts. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.
MRHiLimit The Control System has detected the manual reset high limit switch is open. **Operational Notes:** The Manual Reset High Limit switch is a bimetal switch built into the Outlet Probe (two red wires from probe). This is a normally closed switch that opens on a temperature rise at 244°F (118°C) ± 5.4°F (± 3°C). The purpose of this switch is to prevent excessive outlet water temperatures. The setting is non adjustable/fixed. When the outlet water temperature from the boiler reaches 244°F the switch will open its contacts. The Control System monitors the switch contacts and will declare a fault condition any time the contacts open during a heating cycle. The Control System will display the MRHiLimit Error Message on the UIM's LCD display. To reset the lock out condition, press the Select Button on the UIM while the Error Message is displayed. Keep in mind the outlet water temperature must cool down to approximately 180°F (82.2°C) before pressing the Select Button will reset the control.	• Check all wiring, plugs and sockets between the MCB J7 Socket and the Outlet Temperature Probe. Ensure all connectors, plugs and sockets are making good contact. Repair/replace any damaged wiring or connectors. See MCB - Section E on page 24. • Check the outlet water temperature, ensure the outlet water temperature from the boiler is not reaching 244°F (118°C). • If the outlet water temperature is not at or above 244°F (118°C) disconnect the MCB J7 wiring harness plug (page 24) and check for continuity between pins 1 and 2 on the plug end (two red wires). If the circuit is open, replace the Outlet Temperature Probe. • Ensure the outlet water valve has not been throttled too far in the closed position during water flow set up and causing excessive outlet water temperatures, see Water Flow Setup on page 37. • Check temperature rise (ΔT / Delta T) through the boiler at 100% firing rate. Ensure ΔT is not above 30°F. De-lime boiler if necessary - lime accumulation within the boiler (over time) can reduce water flow and cause excessive temperature rise. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
Low Gas The Control System has detected the Low Gas Pressure Switch contacts are open. Possible causes for this include: • Supply gas pressure has dropped below the pressure activation point of the Low Gas Pressure Switch. • Wiring/plugs/socket connections to the Low Gas Pressure Switch are not making good contact; the Low Gas Pressure Switch circuit is open. • Supply Gas Pressure Switch is defective. **Operational Notes:** The Low Gas Pressure Switch is a normally open switch that closes its contacts on a rise in pressure. Switch contacts will close at +4.0" W.C. on natural gas models and at +6.4" W.C. on propane gas models. Low Gas Pressure Switch is standard on VF Boilers. SW1 dip switch #7 is turned on to configure the Control System to monitor this switch, see MCB - Section D on page 23. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	• Check all wiring, plugs and sockets between the Low Gas Pressure Switch and the J5 Socket on the MCB. Ensure all connectors, plugs and sockets are making good contact. Repair/replace any damaged wiring or connectors. See page 21 and the wiring diagram that came with the Boiler. • Measure and record the supply gas pressure to the Boiler when the Boiler is firing at 100% in the Max Mode. Follow the instructions in the Start Up Procedure on page 35 to measure supply gas pressure. • The supply gas pressure must stay above +4.0" W.C. for natural gas and +6.4" W.C. for propane gas models during operation, see Figure 5 on page 11. • Adjust gas supply pressure at the regulator serving the Boiler if the measured supply gas pressure is less than the gas pressures listed above. • If the supply gas pressure drops below the pressures listed above during operation and adjustment at the regulator does not solve the problem - ensure the regulator and supply gas line are properly sized according to the sizing requirements in the Instruction Manual that came with the Boiler. • If the measured supply gas pressure is maintained above +4.0" W.C. on natural gas models and above +6.4" W.C. on propane gas models during operation at 100% firing mode - replace the Low Gas Pressure Switch if all the above steps have been performed and the results were successful. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
No Flow **Pump IS NOT Running** (If the pump is running see "No Flow - Pump Is Running" on the following page) The Control System has detected the normally open contacts on factory mounted Flow Switch are not closing or are not remaining closed after the pump is energized. See Figure 2 on page 8 for location of Flow Switch on the back of the boiler. **Service Notes:** The power should be on with a call for heat present when performing the voltage checks described in the right column. The boiler's control system may continue to lock out after the allotted time to prove the pump is operating properly via the flow switch has expired. See Resetting Control System Lock Outs on page 48. Reset Control System lock out conditions as necessary to conduct the diagnostic procedures listed here. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	**Field Installed Boiler Circulation Pump** • Check for power at the pump motor wiring/terminals. If the pump is being supplied with the correct voltage (see field installed pump rating plate) but will not start - replace/repair the pump. • If the field installed pump is equipped with a dual (multiple) voltage motor, ensure the pump motor wiring has been correctly configured for the voltage supplied, see field installed pump rating plate and manufacturer's instructions for voltage conversions. • If power is not present - ensure all field installed pump controls, wiring, connectors, and relays or starters are functioning correctly. Make necessary repairs to restore power to pump, see Field Supplied Boiler Circulation Pumps on page 30. • If a field installed pump receives power from the boiler's pump relay and/or PDB circuit board check fuse and pump relay as outlined in the steps listed for models with factory installed pumps below. **Factory Installed Boiler Circulation Pump** • Check for 120 VAC at the pump motor wiring/ terminals. If the pump is being supplied with 120 VAC but will not start - replace/repair pump. • Check F2 fuse on PDB - replace fuse if blown, see page 30. • Check for 120 VAC at MCB J2 socket pins 1 & 2 supplying power to the pump relay coil, see page 22. • Check for 120 VAC at pump relay coil terminals. If correct voltage is not present check all wiring between MCB J2 socket pins 1 & 2 and the pump relay. Ensure the MCB J2 plug/socket pins are in good condition and making good contact - repair/ replace anything worn or damaged. • Ensure pump relay N.O. (normally open) contacts are closing with 120 VAC supplied to the pump relay coil. If contacts do not close - replace pump relay. • Check for 120 VAC hot to the N. O. contact terminal of the pump relay at TB1 terminal 1 on the PDB (page 29). Check to ground/neutral. • Check for 120 VAC hot return from the Common contact terminal of the pump relay at TB1 terminal 3 on the PDB (page 29). Check to ground/neutral. • Check for 120 VAC to the pump motor between TB1 terminals 4 & 5 on the PDB (page 29). • Ensure hot/neutral wires from pump are in good condition and properly connected to TB1 terminals 4 & 5 on the PDB (page 29). • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
No Flow **Pump IS Running** (If the pump is not running see "No Flow - Pump Is Not Running" on the preceding page) The Control System has detected the normally open contacts on factory mounted Flow Switch are not closing or are not remaining closed after the pump is energized. See Figure 2 on page 8 for location of Flow Switch on the back of the boiler. **Installation Notes:** The combined total of supply and return water piping must not exceed 50 equivalent feet on VF boilers equipped with a “factory installed” pump. Exceeding this limitation can and will cause “No Flow” Error Messages and Control System lock outs. Be certain all elbows and fittings in the supply and return lines between the boiler and the storage tank or heating loop are considered in the equivalent feet calculations. Installations that exceed the 50 equivalent foot limitation described above require field supplied and installed Boiler Circulation Pumps that are properly sized for the head loss posed by the supply and return water lines connected to the boiler. See Field Supplied Boiler Circulation Pumps on page 30. **Operational Notes:** The outlet water valve is often throttled partially closed to achieve the proper (20° to 30°) temperature rise (ΔT) through the boiler. If the outlet water valve is throttled closed too far or the inlet water valve is not left 100% open at all times during operation it can cause No Flow Error Messages and Control System lock outs. Ensure the water flow has been properly set during Start Up, see Water Flow Setup on page 37. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	**New Boiler Installation In Existing Systems** • Check for restrictions inside the water lines (accumulated lime) to and from the boiler. System lines can become restricted with lime and sediment accumulation over long periods of time. In older systems the existing boiler supply and return water lines may be too restrictive for this reason and need to be replaced. **All Installations** • Ensure existing water lines to and from the boiler are properly sized. Supply and return lines to the boiler must not be smaller than the inlet and outlet connections on the boiler. Existing water lines may be undersized (too restrictive) and need to be replaced. • Ensure the supply and return water lines to the boiler have not exceeded the maximum allowed. See the Installation Notes in the first column of this table. • Ensure the inlet water valve to the boiler is 100% open during operation. • Ensure the outlet water valve has not been throttled too far in the closed position during water flow set up, see the Operational Notes in the first column of this table. • Ensure Flow Switch is wired correctly using the Common and Normally Open contact terminals. • Ensure the boiler, supply/return lines, storage tank, building loop, and all water system components are purged of air. • Cycle the boiler off and check condition of Flow Switch and paddle - replace worn or missing paddle - replace Flow Switch if damaged or defective. • Check temperature rise (ΔT / Delta T) through the boiler at 100% firing rate. Ensure ΔT is not above 30°F. De-lime boiler if necessary - lime accumulation within the boiler (over time) can reduce water flow and cause excessive temperature rise. • If ΔT at 100% firing rate is 20°F to 30°F, adjust setting screw on Flow Switch to close contacts while the pump is running. If flow switch cannot be adjusted to close contacts when temperature rise/flow rate is between 20°F to 30°F- replace the Flow Switch. • Turn off power to the boiler and disconnect the two wires to the Flow Switch. **TEMPORARILY INSTALL JUMPER WIRE** between the two wires. Restore power to the boiler. • If the Error Message persists with jumper wire installed - call the toll free support phone number on the back cover of this manual for further assistance. • **REMOVE JUMPER WIRE IMMEDIATELY AFTER PERFORMING THIS TEST. FAILURE TO DO SO CAN RESULT IN PROPERTY DAMAGE, PERSONAL INJURY AND/OR DEATH.**

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR

Inlet Probe
The Control System has detected an open or shorted Inlet Temperature Probe when the Inlet Temperature Probe is configured as the Controlling Probe. See The Controlling Probe on page 7 and MCB - Section D on page 23. The Control System will declare a fault condition and lock out in this condition displaying the "Inlet Probe" Error Message on the UIM's LCD.
If the Inlet Temperature Probe is not configured as the Controlling Probe and the Inlet Temperature Probe circuit is open or shorted, the boiler will continue to operate. In this condition the UIM's LCD display will show dashed lines (-----) in place of the Inlet temperature reading when the Inlet Temperature Probe circuit is open and will display the word "Short" when the circuit is shorted. See the illustrations below.
`  Outlet 140°F`
`- Inlet ------`
`= Delta T 50°F`
`  Tank 115°F <<<<`
`  Outlet 140°F`
`- Inlet Short`
`= Delta T ------`
`  Tank 115°F <<<<`
Installation Notes:
Each VF Boiler is fired and the optimal combustion is set before leaving the factory. The Inlet Probe is configured as the Controlling Probe at the factory during this process. The Inlet Probe **MUST NOT** be configured as the Controlling Probe when the boiler is installed. All VF Boilers are supplied from the factory with a Remote Temperature Probe to be installed in a storage tank on domestic water applications or in the return loop in hydronic heating systems. The Remote Temperature Probe **MUST BE** configured as the Controlling Probe on all applications, see the The Controlling Probe on page 7 and the SW1 dipswitch information on page 23.
With the boiler properly configured and installed the "Inlet Probe" Error Message should never be displayed.
Important Service Reminder:
When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.
	• Check the plug/socket connection at the MCB J8 Socket, see MCB - Section E on page 24. Ensure the plug/socket pins are in good condition and making good contact - repair/replace anything worn or damaged.
	• Ensure the wiring between the MCB J8 Socket and the Inlet Temperature Probe are not pinched and are continuous - repair/replace anything worn or damaged.
	• Turn power off to the boiler. Unplug the MCB J8 wiring harness plug. Measure and record resistance between pins 2 and 5 of the J8 plug. If the measured resistance is less than 317 ohms or greater than 177,000 ohms - replace the Inlet Temperature Probe.
	Service Note:
	Resistance from any factory supplied/installed temperature probe is shown in Table 3 on page 16.
	• Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
Tank Probe The Control System has detected an open or shorted Remote (Tank/Loop) Temperature Probe circuit when the Remote Temperature Probe, or optional Quad Thermistor Probe, is configured as the Controlling Probe. See The Controlling Probe on page 7 and the SW1 dipswitch information on page 23. If the Remote Temperature Probe or the optional Quad Thermistor Probe is not configured as the Controlling Probe and the Remote Temperature Probe circuit is open or shorted, the boiler will continue to operate. In this condition the UIM's LCD display will show dashed lines (-----) in place of the Tank temperature reading when the Remote Temperature Probe circuit is open and will display the word "Short" when the circuit is shorted. See the illustrations below. Outlet 140°F - Inlet 125°F = Delta T 15°F <20 Tank ------ Outlet 140°F - Inlet 125°F = Delta T 15°F <20 Tank Short **Installation Notes:** Each VF Boiler is fired and the optimal combustion is set before leaving the factory. The Inlet Probe is configured as the Controlling Probe at the factory during this process. The Inlet Probe **MUST NOT** be configured as the Controlling Probe when the boiler is installed. All VF Boilers are supplied from the factory with a Remote Temperature Probe to be installed in a storage tank on domestic water applications or in the return loop in hydronic heating systems. The Remote Temperature Probe, or optional Quad Thermistor Probe **MUST BE** configured as the Controlling Probe on all applications, see the The Controlling Probe on page 7 and the SW1 dipswitch information on page 23. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	• Check the plug/socket connection at the MCB J9 Socket, see MCB - Section E on page 24. Ensure the plug/socket pins are in good condition and making good contact - repair/replace anything worn or damaged. • Ensure the wiring between the MCB J9 Socket and the Remote Temperature Probe or optional Quad Thermistor Probe (see pages 15 and 16) are not pinched and are continuous - repair/replace anything worn or damaged. Ensure wiring ran in field installed conduit between the boiler and the Remote Temperature Probe is continuous. • Turn power off to the boiler. Unplug the MCB J9 wiring harness plug. Measure and record resistance between pins 3 and 4 of the J9 plug. Measurement may also be taken at the probe if the wiring is disconnected. • If the measured resistance is less than 317 ohms or greater than 177,000 ohms - replace the Remote Temperature Probe. • If the measured resistance is less than 317 ohms or greater than 177,000 ohms - replace the Quad Thermistor Probe or connect the wiring from the boiler's MCB J9 socket to an unused thermistor circuit in the Quad Thermistor Probe if available. **Service Note:** Resistance from any factory supplied/installed temperature probe is shown in Table 3 on page 16. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
Outlet Probe The Control System has detected an open or shorted Outlet Temperature Probe circuit. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	• Check the plug/socket connection at the MCB J7 Socket, see MCB - Section E on page 24. Ensure the plug/socket pins are in good condition and making good contact - repair/replace anything worn or damaged. • Ensure the wiring between the MCB J7 Socket and the Outlet Temperature Probe are not pinched and are continuous - repair/replace anything worn or damaged. • Turn power off to the boiler. Unplug the MCB J7 wiring harness plug. Measure and record resistance between pins 4 and 5 of the J7 plug. If the measured resistance is less than 317 ohms or greater than 177,000 ohms - replace the Outlet Temperature Probe. **Service Note:** Resistance from any factory supplied/installed temperature probe is shown in Table 3 on page 16. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.
Igniter The Control System has detected less than 2.7 AC amps through the Igniter during the Igniter Warm Up period. **Operational Notes:** The Control System is programed to monitor amperage through the Igniter during the Igniter Warm Up period and requires a minimum of 2.7 AC amps before energizing the 120 VAC Gas Valve for ignition. This is to ensure the Igniter is hot enough to ensure ignition. See the Sequence Of Operation on page 45. **Service Notes:** VF Boilers use a hot surface igniter (HSI). Igniters are wearing parts that will require replacement during the life of the boiler. The lifespan of an Igniter is directly proportional to how many times it is energized. Short cycling (repeated heating cycles of short duration) will increase Igniter cycles and diminish its lifespan. The most common cause of short cycling is a low "Setpnt Diff" setting in the User Settings Menu. The lower the Setpnt Diff setting the more the boiler will cycle on and off. The range for the Setpnt Diff is 1° to 50°, the factory default setting is 3°, see Table 4 on page 23. Dividing the "Run Mins by the "Heat Cycles" values shown in the Log & System Info Menu will equal the average minutes per heating cycle. If the average heating cycle minutes is less than 10 minutes, considering raising the Setpnt Diff setting in the User Settings menu to prevent short cycling and increase the lifespan of the Igniter.	• Check all wiring and connections between pins 1 & 2 of the J18 socket on the MCB (see page 22) and the Igniter. Repair/replace any worn or damaged wiring or connectors. • Closely inspect the pins in the J18 socket/plug for wear or damage. Ensure the plug and socket are properly connected and making good contact. • Ensure there is 120 VAC between pins 1 & 2 of the J18 socket on the MCB during the Igniter Warm Up period (blower speed reduces after pre purge cycle is completed). • If 120 VAC is not present at the J18 socket during the Igniter Warm Up period - call the toll free support phone number on the back cover of this manual for further assistance. • Using an AC amp meter, check Igniter amps during Igniter Warm Up period (blower speed reduces after pre purge cycle is completed). If amp draw is less than 3.0 amps replace the Igniter. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
Blower Prover **Combustion Blower IS NOT Running** (If the Combustion Blower is running see "Blower Prover - Combustion Blower Is Running" on the following page) The Control System has not energized the Combustion Blower or the Combustion Blower has failed to start when energized. **Operational & Service Notes:** The BPS (Blower Prover Switch) is dual pressure sensing switch. It is a normally open switch that closes its contacts on a fall in pressure difference between the P1 and P2 pressure sensing ports on the switch. The activation pressure for the switch to close its contacts is -4.0" W.C. (inches water column). This activation pressure is a negative pressure; a slight vacuum. See Control Panel on page 17 for BPS location. The Control System monitors the BPS during the diagnostic system check at the beginning of each heating sequence, before energizing the Combustion Blower, to ensure the normally open switch contacts are open. If the BPS circuit is closed for any reason, the Control System will not energize the blower and will lock out and display the "Blower Prover" Error Message on the UIM's LCD. See the Sequence Of Operation on page 45. The Control System also monitors the BPS during three (3) operating states; pre-purge, inter-purge and post-purge when the blower is running at high speed to ensure the BPS switch contacts have closed to verify the blower is operating at high speed. During the Igniter Warm Up period and Heating Mode operating states, when the blower is running at lower speeds and will not achieve a -4.0" W.C manifold pressure, the Control System is programmed to ignore the state of the BPS switch contacts. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	**Turn the boiler off for the following tests:** • Ensure there is not a jumper wire installed between the two wiring terminals on the BPS (Blower Prover Switch), see Figure 11 on page 18. • Disconnect both wires from the BPS - check for continuity between the two terminals on the switch using an ohm meter. If there is continuity - replace the switch. • Check all wiring between the BPS and the J17 Socket on the MCB, see MCB - Section B on page 21. Ensure the wiring is not shorted/pinched - repair/replace any shorted/damaged wiring. • Check the plug/socket connections at the PDB J3 Socket and the 3 pin 120 VAC connector on the Combustion Blower. Ensure the plug/socket pins are in good condition and making good contact - repair/replace anything worn or damaged, see Figure 4 on page 10 and PDB - Section D on page 32. • Check all wiring between the PDB J3 Socket and the 3 pin 120 VAC connector on the Combustion Blower - repair/replace any wiring that is damaged or worn. • Check the F7 fuse on the PDB - replace the fuse if blown, see PDB - Section B on page 30. **The boiler is turned on with a call for heat active during the following tests:** Perform the voltage tests below by inserting the meter test probes into the back of the wiring harness plugs while they are still inserted in their respective sockets. • Disconnect the two wires to the BPS to ensure there is an open BPS circuit and restart the boiler. The Combustion Blower should start in this condition. • Unplug the 5 pin connector on the Combustion Blower and restart the boiler, see Figure 4 on page 10. The Combustion Blower should start and run at high speed continuously in this condition. If the Combustion Blower does start call the toll free support phone number on the back cover of this manual for further assistance. • Check for 120 VAC at the 3 pin 120 VAC power supply plug on the Combustion Blower, see Figure 4 on page 10 and the wiring diagram that came with the boiler. • Check for 120 VAC between pins 1 and 2 of the J3 Socket on the PDB. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
Blower Prover **Combustion Blower IS Running** (If the Combustion Blower is not running see "Blower Prover - Combustion Blower Is Not Running" on the preceding page) The Control System has not verified the Blower Prover Switch contacts are closed during the pre-purge, inter-purge or post-purge operating states. **Operational & Service Notes:** The BPS (Blower Prover Switch) is dual pressure sensing switch. It is a normally open switch that closes its contacts on a fall in pressure difference between the P1 and P2 pressure sensing ports on the switch. The activation pressure for the switch to close its contacts is -4.0" W.C. (inches water column). This activation pressure is a negative pressure; a slight vacuum. See Control Panel on page 17 for BPS location. The Control System monitors the BPS during the diagnostic system check at the beginning of each heating sequence, before energizing the Combustion Blower, to ensure the normally open switch contacts are open. If the BPS circuit is closed for any reason, the Control System will not energize the blower and will lock out and display the "Blower Prover" Error Message on the UIM's LCD. See the Sequence Of Operation on page 45. The Control System also monitors the BPS during three (3) operating states; pre-purge, inter-purge and post-purge when the blower is running at high speed to ensure the BPS switch contacts have closed to verify the blower is operating at high speed. During the Igniter Warm Up period and Heating Mode operating states, when the blower is running at lower speeds and will not achieve a -4.0" W.C manifold pressure, the Control System is programmed to ignore the state of the BPS switch contacts. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	• Ensure the sensing tubes connected to the BPS (Blower Prover Switch) and the BIS (Blocked Intake Air Switch) are not kinked or disconnected, see Figure 11 on page 18. • Ensure the sensing tubes connected to the P1 and P2 ports on the BPS are routed to the correct A and B sensing ports on the boiler, see Figure 11 on page 18 for proper sensing tube routing and connections. If these two sensing tube connections are reversed, it will cause this Control System lock out. • Check all wiring between the BPS and the J17 Socket on the MCB, see MCB - Section B on page 21. Ensure the wiring is continuous and is not pinched or cut - repair/replace any damaged wiring. • Check the plug/socket connections at the J17 Socket on the MCB. Ensure the plug/socket pins are in good condition and making good contact - repair/replace anything worn or damaged. • With the boiler turned on, a call for heat active and the Combustion Blower running at high speed during the pre-purge operating state measure and record the manifold gas pressure using a digital manometer. Follow the procedure shown in the Manifold Gas Pressure Test on page 38. • If the measured manifold gas pressure is below -4.0" W.C (in a deeper vacuum) during the test: Check continuity between the two terminals on the BPS with the wires to the switch disconnected during the pre-purge operating state with the Combustion Blower operating at high speed. If the switch contacts remain open - replace the switch. • If the measured manifold gas pressure does not reach -4.0" W.C with the Combustion Blower operating at high speed during the pre-purge operating state call the toll free support phone number on the back cover of this manual for further assistance. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
Blocked Inlet The Control System has detected the Blocked Intake Air Switch contacts are open during operation. **Operational & Service Notes:** The BIS (Blocked Intake Air Switch) is a normally closed switch that opens its contacts on a fall in pressure. Natural gas model's switch contacts will open at -4.0" W.C. (inches water column). Propane gas model's switch contacts will open at -5.7" W.C.. These activation pressures are negative pressures; a slight vacuum. See Control Panel on page 17 for BIS location and Figure 11 on page 18. The Control System monitors the BIS during the diagnostic system check at the beginning of each heating sequence to ensure the switch contacts are closed. The Control System monitors the BIS during the Heating Mode and other operating states also. If the BIS circuit is open for any reason during operation the Control System will lock out and display the "Blocked Inlet" Error Message on the UIM's LCD. See the Sequence Of Operation on page 45. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	**Turn the boiler off for the following tests:** • On Conventional Vent installations (using room air for combustion) ensure the intake air connection on the boiler is not blocked or clogged with debris. • On Direct Vent installations (using outdoor air through a sealed intake air pipe) ensure the intake air pipe used is not smaller than required by the Instruction Manual that came with the boiler. • On Direct Vent installations ensure the maximum equivalent feet allowed for the intake air pipe has not been exceeded; too many linear feet of pipe, too many elbows. See the Instruction Manual that came with the boiler for complete venting instructions. • On Direct Vent installations ensure there are no low points in the intake air piping that may trap condensate and cause blockage/restriction - correct improper intake air pipe installation/drain condensate from low points in intake air piping. • On Direct Vent installations temporarily disconnect intake air pipe from the boiler and restart the boiler. If the Blocked Inlet Error Message ceases ensure there are no obstructions in the intake air piping. • Disconnect both wires from the BIS - check for continuity between the two terminals on the switch using an ohm meter. If the switch contacts are an open circuit - replace the switch. • Check all wiring between the BIS and the J17 Socket on the MCB, see MCB - Section B on page 21. Ensure the wiring is continuous and is not pinched or cut - repair/replace any damaged wiring. • Check the plug/socket connections at the J17 Socket on the MCB. Ensure the plug/socket pins are in good condition and making good contact - repair/replace anything worn or damaged. **The boiler is turned on with a call for heat active during the following tests:** • With the boiler turned on, a call for heat active and the Combustion Blower running at high speed during the pre-purge operating state measure and record the pressure at the "B" Intake Air sensing port at the combustion air intake to the boiler using a digital manometer, see Figure 11 on page 18. • If the measured manifold gas pressure does not drop below -4.0" W.C on natural gas models or -5.7" W.C. on propane gas models during the test: Check continuity between the two terminals on the BIS with the wires to the switch disconnected and jumpered during the pre-purge operating state with the blower operating at high speed. If the switch contacts open during the test - replace the switch. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
Blocked Flue The Control System has detected the Blocked Flue Switch contacts are open during operation. **Operational & Service Notes:** The BFS (Blocked Flue Switch) is a normally closed switch that opens its contacts on a rise in pressure. Natural gas model's switch contacts will open at +3.5" W.C. (inches water column). Propane gas model's switch contacts will open at +4.0" W.C.. These activation pressures are positive pressures; slightly above atmospheric pressure. See Control Panel on page 17 for BFS location and Figure 11 on page 18. The Control System monitors the BFS during the diagnostic system check at the beginning of each heating sequence to ensure the switch contacts are closed. The Control System monitors the BFS during the Heating Mode and other operating states also. If the BFS circuit is open for any reason during operation the Control System will lock out and display the "Blocked Flue" Error Message on the UIM's LCD. See the Sequence Of Operation on page 45 **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	**Turn the boiler off for the following tests:** • Ensure there are no obstructions in the vent piping causing blockage. • Ensure the vent pipe used is not smaller than required by the Instruction Manual that came with the boiler. • Ensure the required Boot Tee fitting is connected to the boiler's vent connection. Ensure the maximum equivalent feet allowed for the vent pipe has not been exceeded; too many linear feet of pipe, too many elbows. See the Instruction Manual that came with the boiler for complete venting instructions. • Ensure there are no low points in the vent piping that may trap condensate and cause blockage/restriction - correct improper vent installation/drain condensate from low points in the vent piping. • Disconnect both wires from the BFS (Blocked Flue Switch) - check for continuity between the two terminals on the switch using an ohm meter. If the switch contacts are an open circuit - replace the switch. • Check all wiring between the BFS (Blocked Intake Air Switch) and the J5 Socket on the MCB, see MCB - Section B on page 21. Ensure the wiring is continuous and is not pinched or cut - repair/replace any damaged wiring. • Check the plug/socket connections at the J5 Socket on the MCB. Ensure the plug/socket pins are in good condition and making good contact - repair/replace anything worn or damaged. **The boiler is turned on with a call for heat active during the following tests:** • Disconnect the flexible sensing tube from the BFS and connect a digital manometer to the sensing tube. With the boiler turned on, a call for heat active and the blower running at high speed during the pre-purge operating state; measure and record the pressure from the sensing tube with the digital manometer, see Figure 11 on page 18. Reconnect the sensing tube to the switch when finished. • If the measured manifold gas pressure does not rise above +3.5" W.C on natural gas models or +4.0" W.C. on propane gas models during the test: Check continuity between the two terminals on the BFS with the wires to the switch disconnected and jumpered during the pre-purge operating state with the blower operating at high speed. If the switch contacts open during the test - replace the switch. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
Flame The Control System has failed to verify flame sensing current from one of the two Flame Sensors during the Heating Mode or Ignition Verification operating states. **Operational Notes:** VF Boilers are equipped with two Flame Sensors, one is mounted closer to the burner to detect flame during low fire and one is mounted further away to detect flame during high fire. See Figure 5 on page 11. A single wire, connected the J16 spade connector on the MCB is bifurcated (divided) into two wires, each end then connects to one of the two Flame Sensors. The Control System must sense a minimum of 2.5 DC micro amps (2.5 µA) to prove flame at the Burner. See Figure 12 on page 19 and Figure 15 on page 22. The Control System will lock-out after 1 or 3 trials failed attempts for ignition depending on the SW1 #2 dip switch setting on the MCB circuit board. See MCB - Section D on page 23. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	• Ensure the supply gas shut off valve to the boiler and the Manifold Gas Shut Off Valve in the gas train between the 120 VAC Gas Valve and the Venturi are both fully open. See Figure 28 on page 38. • Perform a Start Up, see Start Up Procedure on page 35. • View the burner through the view port near the Igniter on the top of the Heat Exchanger near the Blower Adapter, see Figure 5 on page 11. Determine if the Burner is igniting momentarily and then going out or there is not any flame. • Ensure the wiring between the Flame Sensors and the J16 Spade connector on the MCB. Ensure the wiring is continuous and is not pinched or cut - repair/replace any damaged wiring, see page 22. • Ensure the wiring connectors at the Flame Sensors and at the J16 spade connector on the MCB are making good contact. • If the flame sensor wiring is in good condition - perform a flame sensing test. Using a DC micro amp meter; place the meter test probes in series with the flame sensor wire. Disconnect the wire at the J16 connect on the MCB. Insert the tip of one test probe into the wire connector securely - touch and hold the other test probe to the J16 connector on the MCB. Measure the flame sensing current during ignition. If the flame sensing current is less than 2.5 µA - remove, inspect, and clean both flame sensors. 5.0 µA flame sensing current is typical. If either flame sensor shows signs of damage or the ceramic insulator is cracked - replace the flame sensor (s). If the flame sensors are in good condition clean both sensors with fine steel wool and reinstall both sensors. Check flame sensing current again to see if the current is higher and burner flame is established. • Ensure the 120 VAC Gas Valve is being energized during ignition: Check for 120 VAC between pins 1 & 2 of the J19 socket on the MCB at the end of the Igniter Warm Up period, see MCB - Section B on page 21. If 120 VAC is present - check all wiring between the J19 socket and the gas valve. Ensure the wiring is continuous and is not pinched or cut - repair/replace any damaged wiring. If 120 VAC is not present during this test call toll free support phone number on the back cover of this manual for further assistance. • Check the plug/socket connections at the J5 Socket on the MCB. Ensure the plug/socket pins are in good condition and making good contact - repair/replace anything worn or damaged. • Proceed to next page for additional Check/Repair diagnostic procedures.

DISPLAYED MESSAGE/CONDITION/INDICATES	CHECK/REPAIR
Flame (continued) The Control System has failed to verify flame sensing current from one of the two Flame Sensors during the Heating Mode or Ignition Verification operating states. **Operational Notes:** VF Boilers are equipped with two Flame Sensors, one is mounted closer to the burner to detect flame during low fire and one is mounted further away to detect flame during high fire. See Figure 5 on page 11. A single wire, connected the J16 spade connector on the MCB is bifurcated (divided) into two wires, each end then connects to one of the two Flame Sensors. The Control System must sense a minimum of 2.5 DC micro amps (2.5 µA) to prove flame at the Burner. See Figure 12 on page 19 and Figure 15 on page 22. The Control System will lock-out after 1 or 3 trials failed attempts for ignition depending on the SW1 #2 dip switch setting on the MCB circuit board. See MCB - Section D on page 23. **Important Service Reminder:** When performing any troubleshooting steps outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to a given component before replacing any electrical part or component.	• Check the supply gas pressure to the boiler. Follow the instructions in Start Up Procedure on page 35 to measure and record the supply gas pressure, see Figure 27 on page 37. Ensure the measured supply gas pressure is within the minimum and maximum supply gas pressure limitations given in the Instruction Manual that came with the boiler. Raise/ lower supply gas pressure to the boiler at the supply gas regulator as necessary. • If the supply gas pressure to the boiler is low and adjustment at the supply gas pressure regulator does not supply the minimum pressure required. Ensure the regulator is functioning properly. Ensure the regulator and the supply gas line have been sized properly, repair/replace the supply gas regulator/ supply gas line if undersized or defective. Restore required supply gas pressure to the boiler. • If the supply gas pressure to the boiler is adequate, ensure the 120 VAC Gas Valve is opening and gas is flowing through the valve during ignition: Turn off power to the boiler. Remove the gas pressure 1/8 inch test plug at the outlet of the boiler's 120 VAC Gas Valve. Install a barbed hose adapter fitting in this test port. Connect a U-tube or digital manometer to the barbed fitting. Close the Manifold Gas Shut Off Valve in the gas train between the 120 VAC Gas Valve and the Venturi, see Figure 28 on page 38. Turn power to the boiler back on - ensure there is a call for heat present. The blower will reduce speed as the Igniter Warm Up period begins. The gas valve is energized at the end of the Igniter Warm Up Period. With the Manifold Gas Shut Off Valve in the closed position, there will be pressure increase at the 120 VAC Gas Valve outlet when the valve is energized. A positive pressure should be measured from the outlet test port on the gas valve. The measured pressure should be approximately the same as supply gas pressure to the inlet of the valve. If there is no pressure increase when performing this test. Turn off power to the boiler, shut off supply gas to the boiler and remove the 120 VAC Gas Valve - clean/ remove any obstructions or debris from the inlet and outlet of the gas valve. • If the gas valve is being energized and all the above tests have been performed and there is no gas pressure increase at the gas valve outlet during this test - call the toll free support phone number on the back cover of this manual for further assistance. • Call the toll free support phone number on the back cover of this manual for further assistance if the problem has not been corrected after performing the procedures outlined here.

PIPING DIAGRAMS

TEMPERATURE PROBE AND BYPASS LINE LOCATION

On domestic hot water applications the Remote Temperature Probe or the optional Quad Thermistor Probe must be installed in the designated temperature control opening on the storage tank, typically a 3/4 inch NPT opening in the lower portion of the tank. On hydronic heating applications the probe being used must be installed in the return line of the primary hydronic heating loop before (upstream) the first boiler. A field supplied Tee fitting with a 3/4 inch NPT branch is installed in the return line for this purpose, see Figure 33 below, Boiler Controls on page 6 and Temperature Probes on page 15.

Bypass lines must be installed on the “system side” of the Boiler Circulation Pump. A bypass line with a flow control valve should be installed between the inlet and outlet lines of the Boiler as shown in Figure 33. The bypass line and flow control valve should be the same size as the inlet and outlet piping on the Boiler, see Water Flow Setup on page 37.

VF Boilers that are not equipped with a factory installed pump will require a properly sized field installed Boiler Circulation Pump, see Field Supplied Boiler Circulation Pumps on page 30. Field supplied Boiler Circulation Pumps must be installed on the inlet side of the Boiler, flowing to the inlet water connection. Field supplied Boiler Circulation Pumps must also be installed on the boiler side of the bypass line as shown in Figure 33.

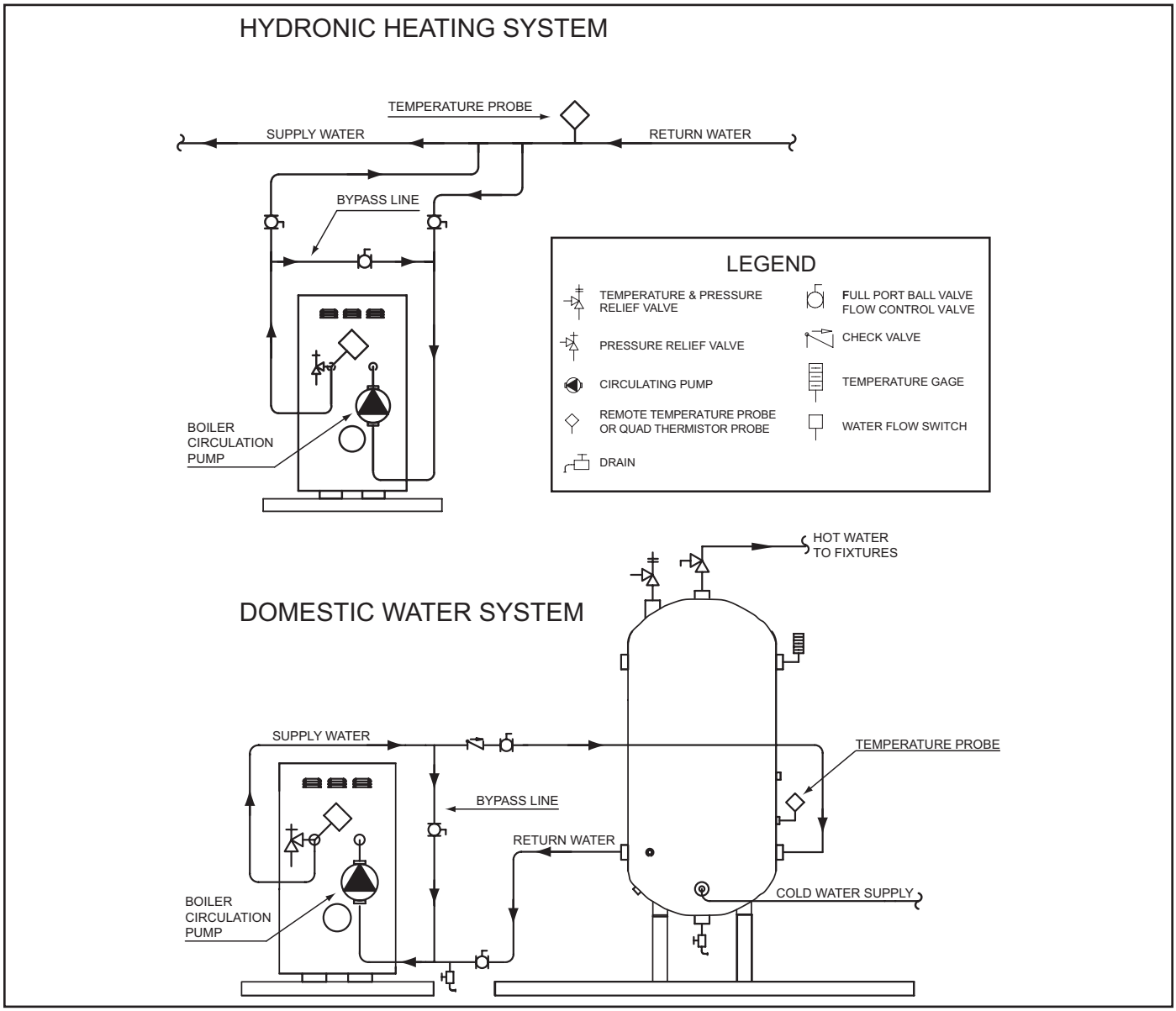
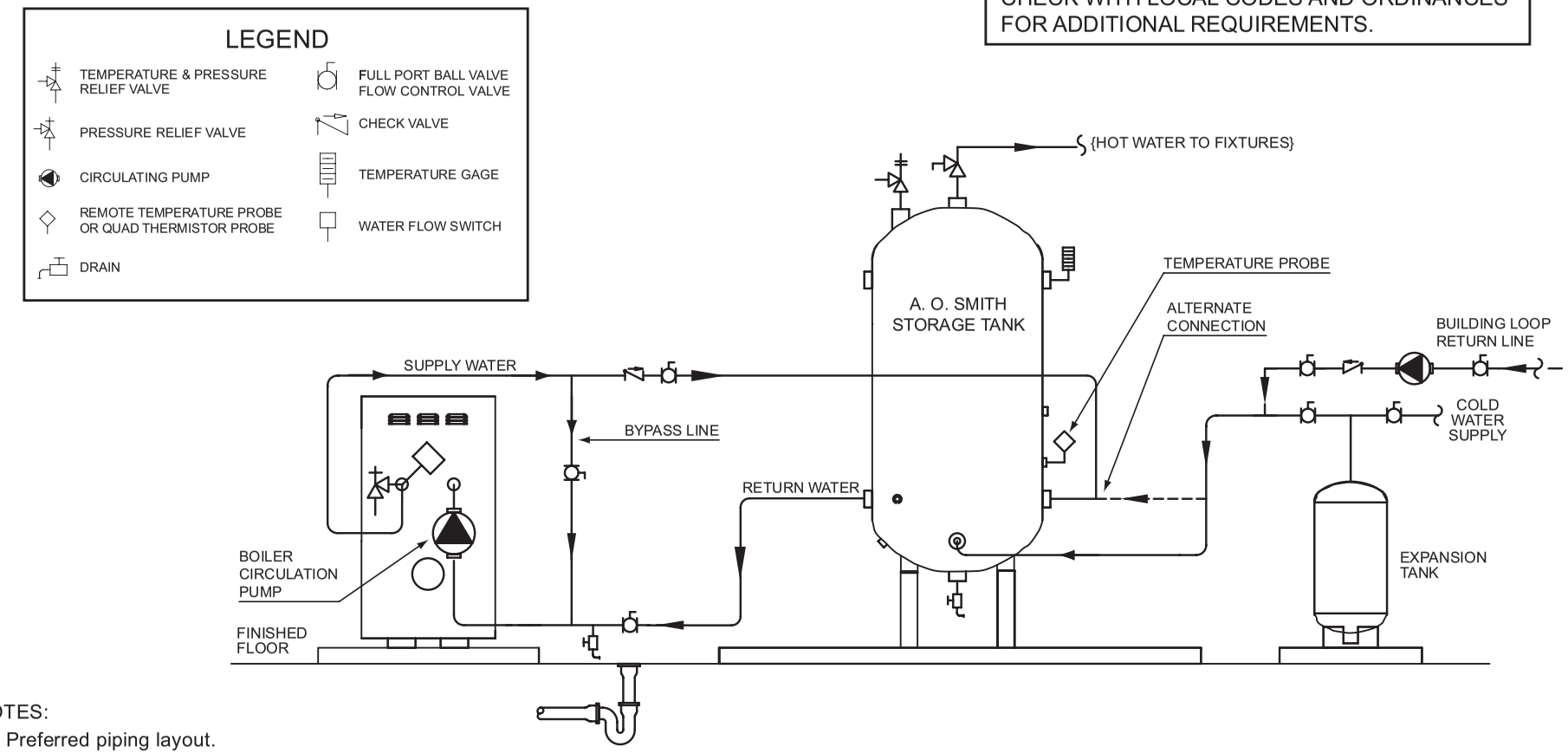


Figure 33

VF BOILER - ONE BOILER VERTICAL STORAGE TANK
SINGLE TEMPERATURE WITH BUILDING RECIRCULATION

CAUTION: THIS DRAWING SHOWS SUGGESTED PIPING CONFIGURATION AND OTHER DEVICES; CHECK WITH LOCAL CODES AND ORDINANCES FOR ADDITIONAL REQUIREMENTS.

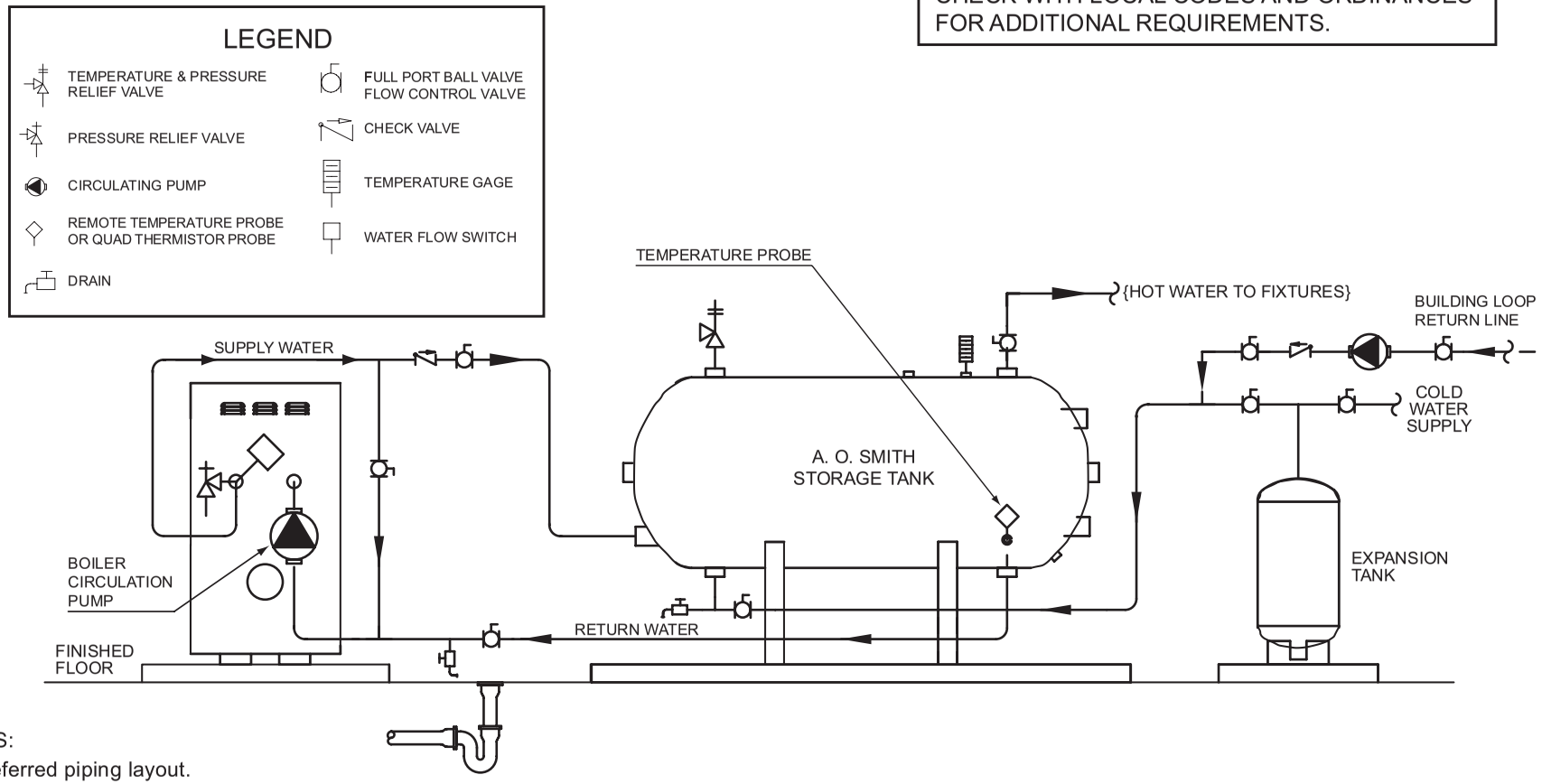


NOTES:
1. Preferred piping layout.
2. Service valves are shown for servicing boiler. However, local codes shall govern their usage.
3. Factory installed boiler circulation pumps are sized for a total maximum of 50 equivalent feet of piping; 25 equivalent feet of supply piping and 25 equivalent feet of return piping.
4. Call the toll free technical support phone number shown on the back cover of this manual or visit www.hotwater.com for multiple boiler piping diagrams.

Figure 34

VF BOILER - ONE BOILER HORIZONTAL STORAGE TANK
SINGLE TEMPERATURE WITH BUILDING RECIRCULATION

CAUTION: THIS DRAWING SHOWS SUGGESTED PIPING CONFIGURATION AND OTHER DEVICES; CHECK WITH LOCAL CODES AND ORDINANCES FOR ADDITIONAL REQUIREMENTS.



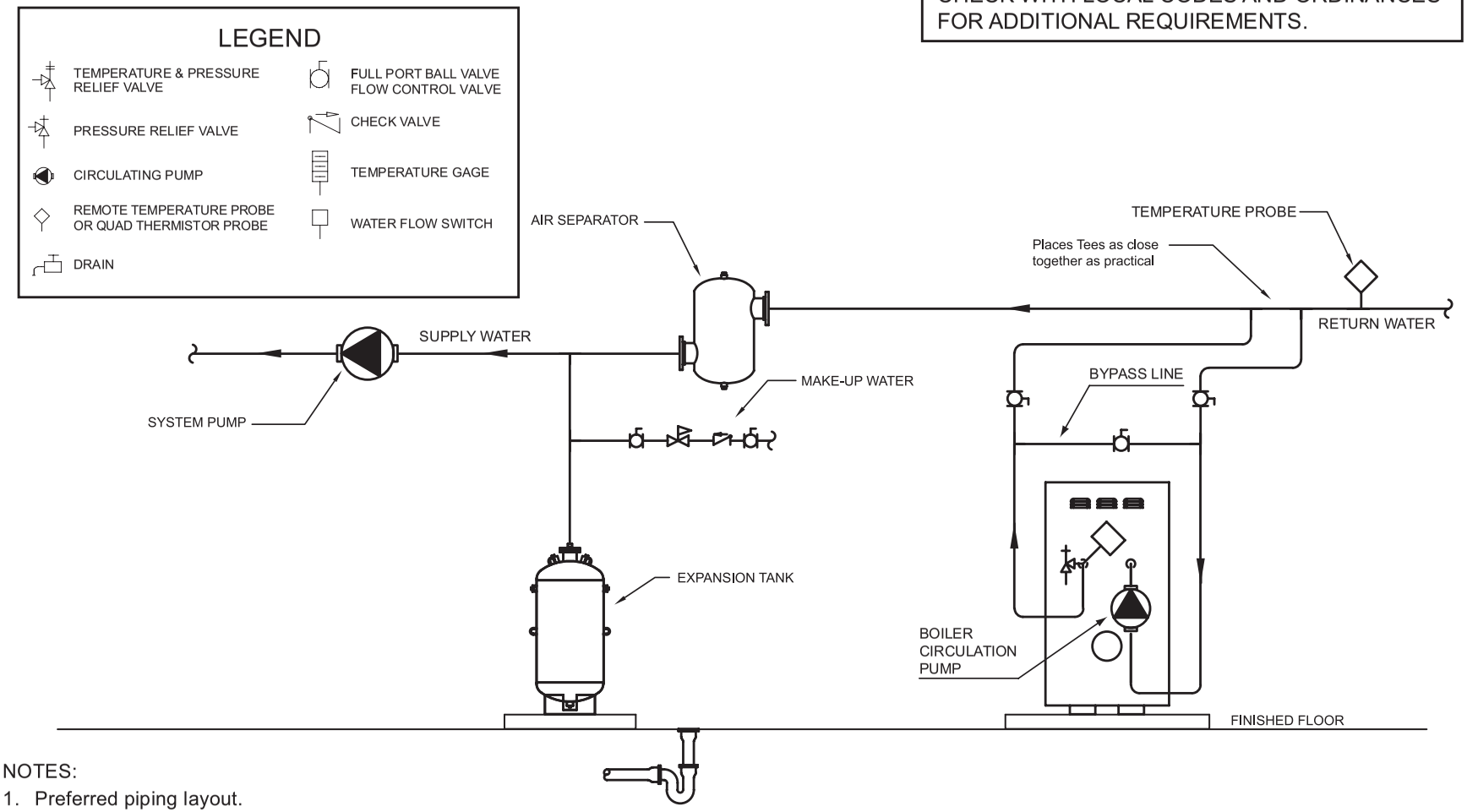
NOTES:

1. Preferred piping layout.
2. Service valves are shown for servicing boiler. However, local codes shall govern their usage.
3. Factory installed boiler circulation pumps are sized for a total maximum of 50 equivalent feet of piping; 25 equivalent feet of supply piping and 25 equivalent feet of return piping.
4. Call the toll free technical support phone number shown on the back cover of this manual or visit www.hotwater.com for multiple boiler piping diagrams.

Figure 35

VF BOILER - ONE BOILER PRIMARY/SECONDARY HYDRONIC PIPING SYSTEM

CAUTION: THIS DRAWING SHOWS SUGGESTED PIPING CONFIGURATION AND OTHER DEVICES; CHECK WITH LOCAL CODES AND ORDINANCES FOR ADDITIONAL REQUIREMENTS.



NOTES:

1. Preferred piping layout.
2. Service valves are shown for servicing boiler. However, local codes shall govern their usage.
3. Factory installed boiler circulation pumps are sized for a total maximum of 50 equivalent feet of piping; 25 equivalent feet of supply piping and 25 equivalent feet of return piping.
4. Call the toll free technical support phone number shown on the back cover of this manual or visit www.hotwater.com for multiple boiler piping diagrams.

Figure 36

BOILER TEMPERATURE LOGS

SCHEDULING DELIMING MAINTENANCE

It is critically important to set the water temperature rise through the boiler according to the requirements given in the Instruction Manual that came with the boiler, see Start Up on page 34.

Once the water temperature rise (Delta T - ΔT) through the boiler has been set mark the positions of the supply water (outlet) valve and the bypass valve. Remove the valve handles and store them nearby to prevent accidental changes.

Create a simple Boiler Temperature Log (see example on the following page) and keep it near the Boiler. Record inlet and outlet water temperatures and the temperature rise (Delta T - ΔT) on a weekly basis.

When the water temperature rise through the boiler increases by 5°F or more call a Qualified Service Agent to schedule deliming maintenance. At this point the lime accumulation will not be heavy and can usually be removed easily.

Failing to implement regularly scheduled deliming maintenance often results in heavy lime accumulation that is more costly to remove and may completely block the copper tubes inside the Boiler.

BOILER TEMPERATURE LOG†				
DATE/TIME	**OUTLET TEMP**	**INLET TEMP‡**	**TEMP RISE ΔT**	**READINGS TAKEN BY**

† [Outlet - Inlet = Delta T D] Outlet (supply water) temperature minus inlet (return water) temperature equals the temperature rise (Delta ΔT) through the boiler. Readings should be taken weekly. When the ΔT increases by 5°F schedule deliming maintenance to ensure optimal efficiency and prevent heavy lime accumulation i the boiler's heat exchanger.

‡ Sustained inlet water temperatures below 120°F can cause heavy condensation and the formation of copper oxide on the copper heat exchanger tubes. This can restrict the flow of flue gases through the heat exchanger and cause combustion problems. Ensure a bypass line and valve are installed and properly set to raise the minimum inlet water temperature. Call the toll free technical support phone number on the back cover of this manual for further assistance.

BOILER TEMPERATURE LOG†				
DATE/TIME	**OUTLET TEMP**	**INLET TEMP‡**	**TEMP RISE ΔT**	**READINGS TAKEN BY**

† [Outlet - Inlet = Delta T D] Outlet (supply water) temperature minus inlet (return water) temperature equals the temperature rise (Delta ΔT) through the boiler. Readings should be taken weekly. When the ΔT increases by 5°F schedule deliming maintenance to ensure optimal efficiency and prevent heavy lime accumulation i the boiler's heat exchanger.

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† [Outlet - Inlet = Delta T D] Outlet (supply water) temperature minus inlet (return water) temperature equals the temperature rise (Delta ΔT) through the boiler. Readings should be taken weekly. When the ΔT increases by 5°F schedule deliming maintenance to ensure optimal efficiency and prevent heavy lime accumulation i the boiler's heat exchanger.

‡ Sustained inlet water temperatures below 120°F can cause heavy condensation and the formation of copper oxide on the copper heat exchanger tubes. This can restrict the flow of flue gases through the heat exchanger and cause combustion problems. Ensure a bypass line and valve are installed and properly set to raise the minimum inlet water temperature. Call the toll free technical support phone number on the back cover of this manual for further assistance.

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