HEATEC TEC-NOTE

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CONTROLS

Firestorm™ water heaters

SCOPE

This document describes functions of controls on Firestorm water heaters. **(Fig. 1.)** Please see **Heatec Tec-Note** on **BURNER MANAGEMENT CONTROLS** for additional information related to controls of the Firestorm heater.

This document only covers controls of Firestorm heaters in current production. Some earlier heaters have different burner management controls than covered herein. Their display messages will have minor differences from the messages that appear on the current Fireye controls. However, the messages shown for current controls should still be useful despite differences.

GENERAL

Key operator controls and status lights are on the front of the control panel **(Fig. 2.)**. These controls enable the operator to start and run the heater. Other controls are located inside the panel **(Fig. 3.)**

A variety of other controls, indicators and gauges are located at various places on the heater **(Fig. 5)**. Some of these are limit devices that will shut down the heater if abnormal conditions occur. Limit devices are part of an electrical circuit known as the limit circuit. The limit circuit is usually the first place to check when a problem is encountered.

LIMIT CIRCUIT

The limit circuit is known as 3-P. It is a circuit that starts with terminal 3 on the Fireye burner control **(Fig. 3)** and ends with terminal P on the burner control.

When any one of the devices in the circuit opens it will cause the heater alarm indicator light to come *on* and the burner will shut down in a *lockout state*. Moreover, the burner display will show **LOCKOUT 3-P INTLK OPEN.**

The devices listed below are in the 3-P circuit and are wired in the same sequence they are listed.

1. High fuel gas pressure switch **(Fig. 8)**
2. Low fuel gas pressure switch **(Fig. 9)**
3. High flue gas stack temperature switch **(Fig. 10)**
4. Combustion air auxiliary contacts **(D, Fig. 4)**
5. Low combustion air switch **(Fig. 11)**

Figure 1. Heatec Firestorm heater.

In case of an abnormal shutdown, you need to identify which device initiated the shutdown (next topic).

IDENTIFYING CAUSE OF SHUTDOWN

If you look at the clear status lights on the control panel after the shutdown occurs, the first one that is *out* normally indicates the device that caused the shutdown.

Once you have an indication that a particular device in the limit circuit caused the shutdown, you can use a voltmeter to confirm that it is actually open. A device is open when voltage is present on the terminal connection on one side of the device, but *not* present on the terminal connection on its other side.

Terminals for these devices are inside the heater control panel. They are marked for easy identification. Use the wiring diagram furnished with your heater to identify the appropriate terminals for the devices.

To check for voltage, connect one voltmeter lead to one terminal on the device and connect the other lead to neutral or ground. To check for voltage on its *other* terminal, connect one lead to the other terminal and connect the other lead to neutral or ground. Do *not* connect voltmeter leads across both terminals on a device because your voltmeter will *not* show presence of voltage when its contacts are closed.

Note: Earlier panel marking FIREYE FLAME MONITOR is now BURNER DISPLAY

Figure 2. Components outside the control panel.

Note that some of the limit devices automatically reset after an abnormal condition has cleared.

CONTROL PANEL

Controls on the outside of the control panel (**Fig. 2**) consist of burner modulation controller, water pump switch, burner switch, burner display, status lights, alarm light and power disconnect switches. Controls located inside the control panel include burner management controls, PLC, circuit breakers, auxiliary contacts, and relays. (**Fig. 3.**) These items are discussed below. The words set in capital letters match the labels on the panel.

EMERGENCY STOP pushbutton switch (Fig. 2)

Push *in* this switch to immediately shut down the heater. ***Use it only in an emergency.*** The switch incorporates a light that comes *on* when the switch is pushed in. Unlike using the **BURNER** switch to shut down, the emergency stop switch removes electrical power from all other controls and immediately shuts down the heater *without* a post purge. However, on earlier Firestorm heaters, electrical power is not removed. But the burner will shut off after a 15-second post purge.

BURNER MODULATING CONTROLLER (Fig. 2)

The modulating controller normally used is a Yokogawa UT150. It provides two functions:

- Burner modulation control
- Burner on/off control

Burner modulation control. This function of the controller controls heating of the water to maintain a temperature setting that has been preset by the operator. It senses water

temperature from a thermocouple. It processes the output voltage of the thermocouple and sends control signals to the Honeywell modulating actuator **(Fig. 7)**, which either increases or decreases the firing rate as required to maintain water temperature at set point.

Burner on-off control. This function of the modulating controller shuts off the burner completely. This happens if system heat demand decreases, allowing water temperature to reach a limit equal to the set point plus a predetermined value. This value is normally set manually at 10. It is known as a floating value since it creates the limit based on the set point. Thus, if its value is 10 and the set point is 140 degrees F, the limit is 150 degrees F (the sum of 140 plus 10). After the water cools down about 20 degrees the controller initiates a new burner cycle.

Please see separate Tec-Note on setting the Yokogawa UT150 for additional information on the controller.

FIREYE BURNER CONTROLS (Fig. 2)

The Fireye burner controls consist of a Fireye Burner Management Control YB110, Programmer Module YP100, and Display BV512. It is a microprocessor based burner management control system. The system provides the proper burner sequencing, ignition and burner monitoring protection. In conjunction with limit and operating controls it sequences the burner/blower motor, ignition transformer and fuel valves to provide for proper and safe burner operation.

The system will close all fuel valves within four seconds (maximum) following a flame failure or at the end of the pilot trial for ignition period if no flame is detected. An alarm circuit will be energized following a safety lockout.

The system must be reset using a manual reset button on the display after an abnormal condition has been cleared.

WATER PUMP switch (Fig. 2)

This is a manually controlled switch for turning the water pump *on* and *off*. The switch is in series with the breaker auxiliary contacts **(H, Fig. 4)**, of the motor controller and must be closed for power to reach the motor. When the switch is set to **ON**, the water pump will run as long as there is an adequate amount of water in the heater reservoir. The controls are designed to allow a signal from a remote tank to start/stop the heater. The switch must be set to **AUTO** for this feature to work.

BURNER CONTROL switch (Fig. 2)

This is a manually controlled switch for turning the burner *on* and *off*. It must be set to **ON** or **AUTO** for the heater to operate. The controls are designed to allow a signal from a remote tank to start/stop the heater. The switch must be set to **AUTO** for this feature to work. When this switch is set to **ON** the burner will come *on* and *off* as needed, independently of external control signals. The burner switch must be set to **ON** or **AUTO** for any of the five indicator lights to work.

HIGH FUEL GAS PRESSURE indicator light (Fig. 2)

This indicator light denotes the status of the *high* fuel gas pressure switch **(Fig. 8)**. When the light is *on* the fuel gas pressure is normal and the switch is closed. When the light is *off* it indicates that the fuel gas pressure exceeded the setpoint. This switch is part of the limit circuit and will shut down the burner when open. The switch has a manual reset button.

Note: Not all heaters have a *high* fuel gas pressure switch. But the panel may still have an indicator light for the switch. In that case the switch is replaced by a jumper wire. Thus, the light will react the same as it would with a switch in its normal pressure state.

LOW FUEL GAS PRESSURE indicator light (Fig. 2)

This indicator light denotes the status of the *low* fuel gas pressure switch **(Fig. 9)**. When the light is *on* the fuel gas pressure is normal and the switch is closed. When the light is *off* it indicates that the fuel gas pressure dropped lower than the setpoint. This switch is part of the limit circuit and will shut down the burner when open. The switch has a manual reset button.

Note: Not all heaters have a low fuel gas pressure switch. But the panel may still have an indicator light for the switch. In that case the switch is replaced by a jumper wire. Thus, the light will react the same as it would with a switch in its normal pressure state.

HIGH FLUE GAS STACK TEMPERATURE indicator light (Fig. 2)

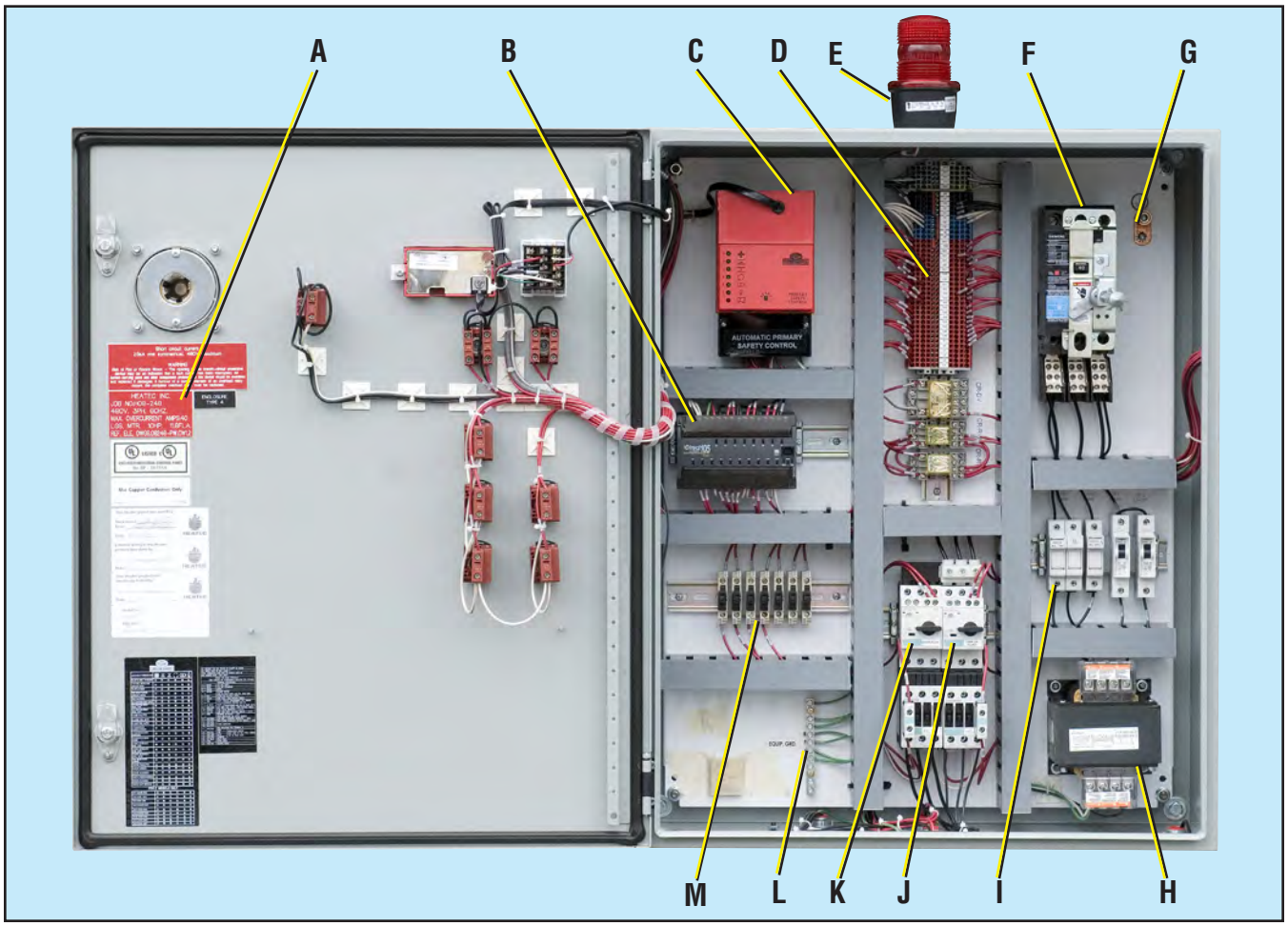
This indicator light denotes temperature status of gas in the exhaust stack. It is electrically connected to the high flue gas stack temperature switch **(Fig. 10)** mounted in the exhaust stack.

When the light is *on,* temperature of the gas is within normal operating range and the switch contacts are closed. When the light is *off,* gas temperature has exceeded its factory setting of 130 degrees F and the contacts are open.

The switch is also part of the limit circuit and will shut down the heater when the switch is opened. The switch must be manually reset.

COMB. AIR MOTOR AUX. CONTACTS indicator light (Fig. 2)

This indicator light denotes the status of auxiliary contacts **(D, Fig. 4)** on the motor controller that connects electrical power to the burner blower motor. When the indicator light is *on* electrical power is connected to the blower motor. When



A. Voltage label
B. PLC (Programmable Logic Controller)
C. Fireye burner management control YB110
D. Terminals and relays
E. Alarm strobe light
F. Main disconnect breaker
G. Grounding lug
H. Control Transformer
I. Circuit breakers and fuse blocks
J. Blower motor controller
K. Water pump motor controller
L. Equipment grounding strip
M. Fused terminals

Figure 3. Components inside the control panel.

the light is *off* the contacts are open because electrical power is not connected to the motor.

The contacts are also part of the limit circuit and will shut down the heater when opened. The contacts automatically close when power is restored to the motor.

COMB. AIR/ALL LIMITS MADE indicator light (Fig. 2)

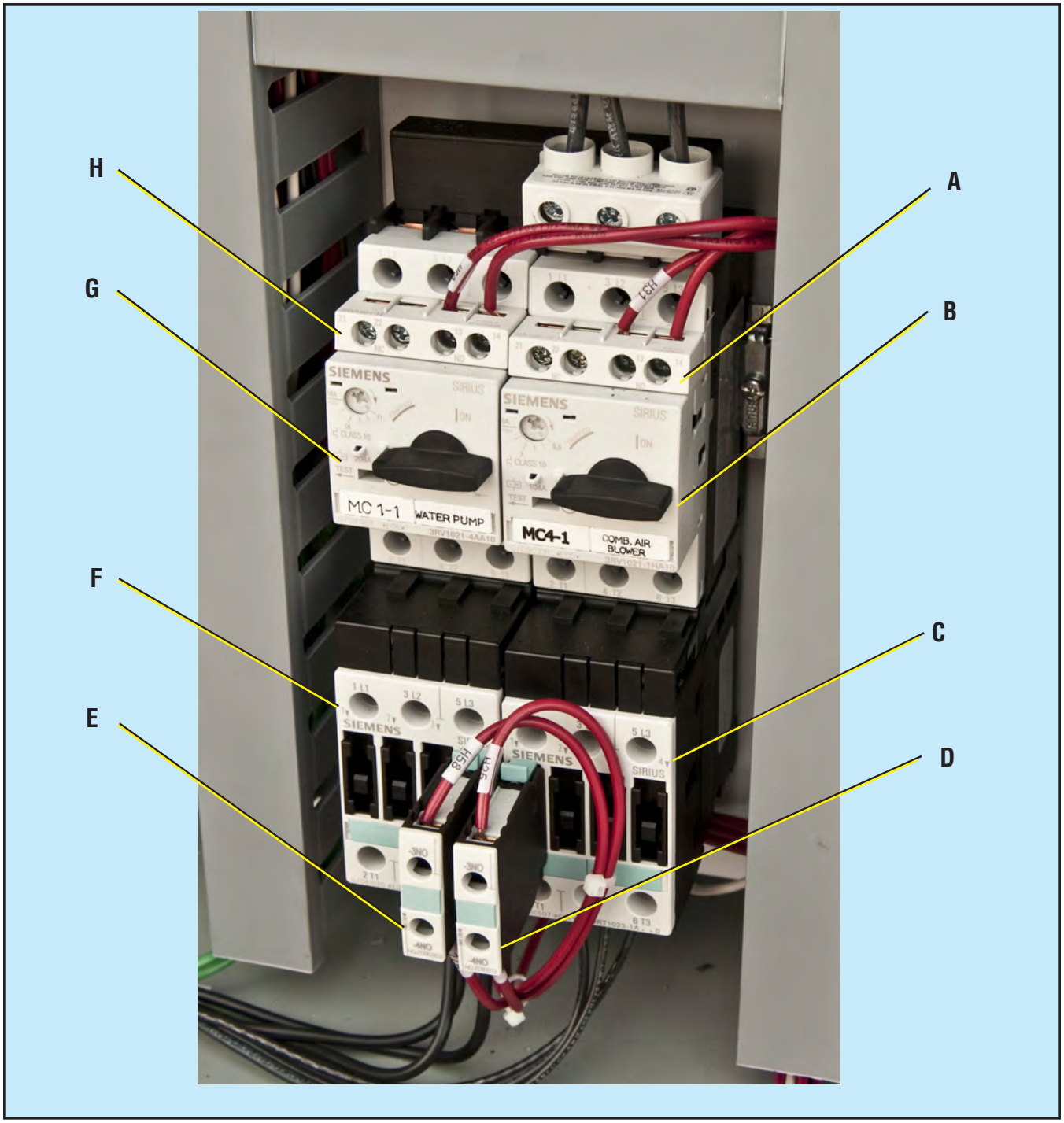
This light functions as a low combustion air pressure light in addition to a limits made light. When the light is *on* it indicates that the combustion air pressure is normal and that the combustion air switch **(Fig. 11)** in the burner housing is closed. When the light is *on* it also indicates that all other limit switches are closed. When the light is *out* the combustion air pressure is too low and the combustion air switch is open.

HEATER ALARM light (E, Fig. 3)

This light denotes the status of the heater alarm system. When the light is flashing the heater is in an alarm state. The alarm is controlled by the Fireye burner control **(C, Fig. 3)**, which turns on the alarm when it detects a variety of abnormal conditions. The Fireye display shows one of several messages to report the condition that caused the alarm.

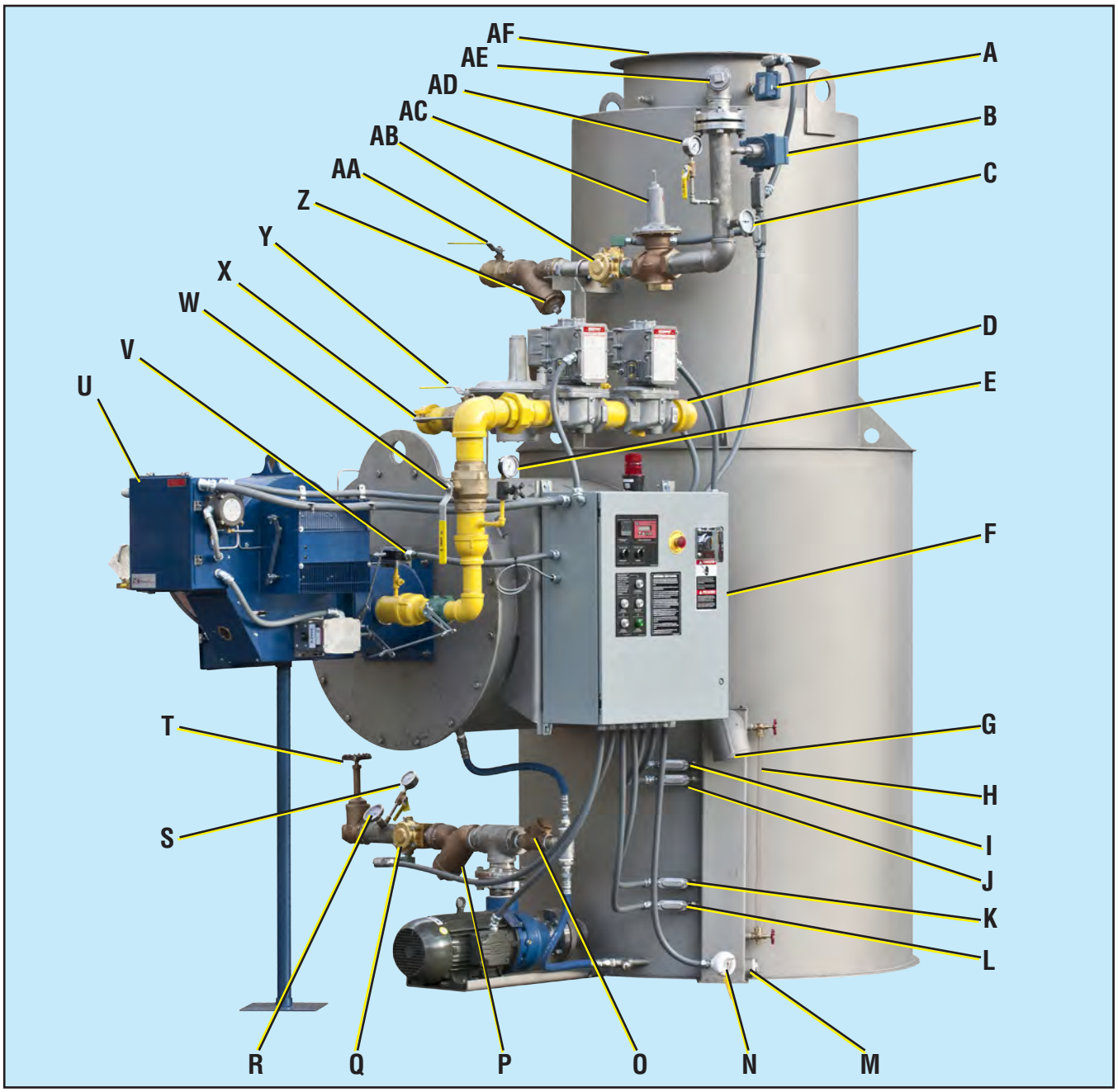
Door handle (Fig. 2)

Use this handle to open the control panel. Do not open the door unless you are a qualified technician familiar with the hazards of electricity.



A. Breaker auxiliary contacts for combustion air blower motor
B. Breaker disconnect for combustion air blower motor
C. Contactor for combustion air blower motor
D. Auxiliary contacts for combustion air blower motor
E. Auxiliary contacts for water pump motor
F. Contactor for water pump motor
G. Breaker disconnect for water pump motor
H. Breaker auxiliary contacts for water pump motor

Figure 4. Components of motor controllers inside the control panel.



A. Stack temperature switch
B. Inlet water pressure switch
C. Inlet water temperature gauge
D. Low gas pressure switch (not visible in photo)
E. Gas pressure gauge
F. Control panel
G. Overflow connection
H. Water level indicator
I. High-high water level switch
J. High water level switch
K. Low water level switch
L. Low-low water level switch
M. Drain connection
N. Thermocouple
O. Check valve
P. Outlet water Y-strainer
Q. Automatic outlet water valve
R. Outlet water temperature gauge
S. Outlet water pressure gauge
T. Manual outlet water valve
U. Burner
V. High gas pressure switch
W. Manual gas leak test valve
X. Pilot gas valve
Y. Manual gas shut off valve
Z. Inlet water Y-strainer
AA. Manual inlet water valve
AB. Automatic inlet water valve
AC. Inlet water pressure regulator
AD. Inlet water pressure gauge
AE. Secondary water connection
AF. Exhaust stack connection

Figure 5. Location of components on Firestorm heater.

As a safety feature the handle shuts off electric power to all electrical components inside the control panel when the panel is opened. However, there is still high voltage on the terminals at the top of the main disconnect breaker. A keyed rod from the main breaker inside the panel engages a slot on the back of the handle. The rod switches the breaker *on* and *off* as the handle is rotated. The handle is marked to indicate its functions.

Be aware that certain heater control panels have electrical circuits that are not shut off by the rotary door-mounted handle. Panels may include live circuits controlled by circuit breakers elsewhere in the plant. Consequently, shutting off the main breaker inside the panel does not remove all power to components within the panel.

Programmable Logic Controller (PLC) (B, Fig. 3)

The PLC is an electronic processor that is programmed to automate the controls of the heater. It has been programmed by an engineer at Heatec and has no provisions for program changes in the field by operators. However, Heatec engineers can create a new program with changes if that ever becomes necessary. The PLC must be returned to Heatec for installation of the new program.

Combustion air auxiliary contacts

Combustion air auxiliary contacts are located inside the control panel. This is a set of *auxiliary* contacts **(D, Fig. 4)** that snaps onto the front of the contactor. The auxiliary contacts open the limit circuit if the breaker for the burner blower motor is tripped. When the limit circuit opens it shuts down the burner in a lockout state. The burner display **(Fig. 2)** will indicate **LOCKOUT 3-P INTLK OPEN.**

The burner cannot be restarted until the burner control and the burner circuit breaker are manually reset. The auxiliary contacts automatically close when power is restored to the motor.

Pump auxiliary contacts

Pump auxiliary contacts are located inside the control panel. This is a set of *auxiliary* contacts **(E, Fig. 4)** that snaps onto the front of the contactor. If the breaker for the pump motor is tripped, the pump will shut off. The pump cannot be restarted until the breaker is manually reset.

The pump will also shut off if the water level drops low enough to trip the *low-low* water level switch. The pump cannot be turned back on until the water level is high enough to reset the *low* water level switch. Although these auxiliary contacts are *not* in the limit circuit, the burner display **(Fig. 2)** will show **STANDBY L1-3 OPEN** while the pump is shutoff**.**

OTHER CONTROLS

Thermocouple (Fig. 6)

One thermocouple is installed near the bottom of the reservoir. The thermocouple is connected to the UT150 controller for temperature regulation.

Figure 6. Thermocouple in reservoir at bottom of heater.

Modulating actuator (Fig. 7)

The modulating actuator controls the firing rate of the burner in response to signals it receives from the burner modulating controller. It controls the firing rate by moving mechanical linkage connected to the gas butterfly metering valve and the air damper to either increase or decrease the firing rate. If linkage becomes loosened from operation it will lose its adjustment and the burner will not operate properly.

The actuator has two cams that are activated when the heater is started up by the Fireye burner control. When startup is initiated the actuator goes to *high fire purge*, causing one cam to close a switch inside the actuator thereby confirming that the system is in high fire purge. Then, after a preset time, the actuator automatically goes to *low fire purge* and the other cam closes another switch inside the actuator thereby confirming that purge is complete and that the system is ready to light in low fire.

Figure 7. Modulating actuator.

High fuel gas pressure switch (Fig. 8)

This is a pressure switch that opens the limit circuit if gas pressure is too *high.* When the limit circuit opens it shuts down the burner in a lockout state. The burner display **(Fig. 2)** will indicate **LOCKOUT 3-P INTLK OPEN.** The switch has a manual reset button.

Figure 8. High fuel gas pressure switch.

Low fuel gas pressure switch (Fig. 9)

This is a pressure switch that opens the limit circuit if gas pressure is too *low*. When the limit circuit opens it shuts down the burner in a lockout state. The burner display **(Fig. 2)** will indicate **LOCKOUT 3-P INTLK OPEN.** The switch has a manual reset button.

Figure 9. Low fuel gas pressure switch.

High flue gas stack temperature switch (Fig. 10)

This is a temperature sensing switch that opens the limit circuit if flue gas temperature exceeds its factory setting of 200 degrees F. When the limit circuit opens, it shuts down the burner in a lockout state. The burner display **(Fig. 2)** will indicate **LOCKOUT 3-P INTLK OPEN.** The switch must be manually reset.

Figure 10. High flue gas temperature switch.

Low combustion air switch (Fig. 11)

This is a switch that opens the limit circuit if combustion air pressure is too low. When the limit circuit opens it shuts down the burner in a lockout state. The burner display **(Fig. 2)** will indicate **LOCKOUT 3-P INTLK OPEN.**

The air pressure switch automatically closes when adequate air pressure is restored.

If the low combustion air switch opens due to low combustion air, the green **COMB. AIR/ALL LIMITS MADE** light will go *out,* but *none* of the clear lights will go *out*. Thus, the indicator light functions as a low combustion air light in addition to a limits made light.

Figure 11. Low combustion air switch.

Gas pilot solenoid (Fig. 12)

This solenoid controls the pilot gas during the burner firing process, which is controlled by the Fireye controls. It opens after the heater has been purged and the damper is set to its low-fire position. It closes after main ignition has been achieved.

Figure 12. Gas pilot solenoid.

Inlet water pressure switch (Fig. 13)

This switch senses the pressure of the inlet water. The switch is set at the Heatec factory. Inlet water pressure must be equal to or higher than the pressure at which the switch is set. Otherwise the heater will not operate. The setting depends on the size of the heater.

If the pressure is lower than the pressure for which the switch is set, the burner will begin its startup sequence, but will shut off and attempt to restart. The startup sequence will appear to be normal until the burner reaches *main flame trial for ignition* (MTFI) at which time it will shut off.

CAUTION

The setpoint of the switch should not be changed to allow operation at a water pressure lower than the setting specified by Heatec. Doing so may prevent the heater from operating properly and could damage the heater.

If the water pressure is too low, the remedy is to find the cause and do what is necessary to obtain the required pressure. If the cause is a clogged water strainer, clean the strainer to restore adequate pressure. Or it may be necessary to find another water source with suitable pressure.

Figure 13. Inlet water pressure switch.

Water level switches (Fig. 5)

Four water level switches are used to monitor the water level in the hot water reservoir in the bottom of the heater shell. Each switch has a float that actuates the switch at a certain water level in the reservoir.

The high-high water level switch **(I, Fig. 5)** shuts down the heater if the water level in the reservoir reaches its *maximum* limit. The high-water level switch **(J, Fig. 5)** opens the outlet water valve when the water level actuates the switch.

The low-low water level switch **(L, Fig. 5)** turns off the water pump and shuts down the heater if the water level reaches its *minimum* limit. The low-water level switch **(K, Fig. 5)** shuts off the outlet water valve when the water level actuates the switch.

Automatic outlet water valves

Some heaters use an outlet water valve that is solenoid actuated **(Q, Fig. 5)**. Other heaters use a water outlet valve that is pneumatically actuated **(Fig. 14)**.

The valve prevents running the heater when the water level in the reservoir in the bottom of the heater shell is too low. It opens and closes to try and keep the water level between the levels controlled by the high water level switch and the low water level switch. It closes when the level goes below the low water level switch. It opens when the level goes above the high water level switch.

Figure 14. Pneumatically actuated automatic outlet water valve.