

Date: June 23, 2009**Bulletin Number: HP603****Subject: Boiler Control Settings for On-Off, Staged, or Modulating Operation**

Today's energy conscious heating contractors know the benefits that low high low and fully modulating power burners provide in larger, commercial type installations. A few key benefits are highlighted below:

- **Efficiency:** Lower fuel consumption. During certain periods throughout the heating season, the load can be satisfied while the burner adjusts between low and high fire.
- **Load demand:** Low high low or modulating burners are more responsive to system load changes by reduced firing as needed.
- **Improved boiler life:** Low high low or modulating burners allow for a more stable temperature change in the boiler when transitioning from low to high fire. Some incorporate a low fire hold feature to provide a more gradual change from lower water temperatures or steam pressures to higher operating temperatures or pressures.
- **Reduced emissions:** During the low to mid range firing position, the volume of stack emissions is reduced.

Control Settings for Water Boilers

In most hydronic heating systems, the typical design water temperature for space heating applications (baseboard, fin tube radiation, etc.) is 180°F. Our example below is based on this. Other systems should be adjusted accordingly.

On-Off or Low High Off Burners

Set the L4006A operating control main scale at 180°F. Adjust the differential (small wheel behind the main adjustment) to 15°F. The purpose of the differential setting is to avoid burner short cycling. This setting must be experimented with until the longest burner cycles can be obtained. Set the L4006E high limit to 230°F with a differential of 5°F. The high limit is a safety device only and will stop the burner in case the operating control malfunctions.

On a call for heat, the burner will start and run until the water temperature reaches the L4006A's operating setpoint of 180°F and the burner will shut off. When the water temperature falls from the main setting by the differential amount ($180^{\circ} - 15^{\circ} = 165^{\circ}$) to 165°F, the burner will restart.

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Set the operator and limit the same as the On-Off Burner. For this type of operation, an L4006A firing rate control must be added to the control sequence. In some cases, such as multiple boiler low-high-low operation, a L4006A low-high-low controller on the boiler may not be used. In these instances, low-high-low operation might be controlled by a boiler staging control that is capable of operating low and high fire stages. For single boiler applications, the firing rate controller is a L4006A. Set the L4006A firing rate controller for 175°F with a 5°F differential.

On a call for heat, the burner will start in low fire and immediately go to high fire until reaching the 175°F setting of the L4006A firing rate controller. When this occurs, the L4006A will open its switch, driving the burner to low fire. If the temperature drops below the 5°F differential of 170°F, the burner will drive back to high fire. Depending on the boiler load, the burner may run between low and high fire without shutting down. This is the desired affect. If the system load decreases to the point where low fire is more than what the system requires, the boiler water temperature will rise to the operating control setting of 180°F and the burner will shut off.

Full Modulation Burners

Set the operator and limit the same as the On-Off Burner. For this type of operation, a T991A firing rate control must be added to the control sequence. Some multiple boiler staging controls can modulate the burner directly, without the use of a T991A firing rate control installed on the boiler. Other control scenarios may require a local/remote switch to allow firing rate control from either the boiler staging control, or, in the local position, through it's boiler mounted T991A control. Typically, for single boiler installations, a T991A firing rate control is used. Set the knob on the front of the T991A to 175°F. This is the center of the modulating range. Open the case and set the proportioning range adjustment wheel to 10°F (this provides 5° above and 5° below the setting on the front of the control). The control will modulate the burner from 170°F to 180°F.

On a call for heat, the burner will start in low fire and immediately go to high fire until the boiler water temperature reaches the lower point of the modulating control of 170°F. At this temperature, the burner begins to module down. Under ideal circumstances, the firing rate controller can balance load demand versus fuel input as it

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locates the exact firing rate to keep the burner running continuously. If the system load decreases to the point where low fire is more than what the system requires, the boiler water temperature will rise to the operating control setting of 180°F and the burner will shut off.

Control Settings for Steam Boilers

The controls used on a steam boiler are similar in function to the same controls used on a water boiler, except they work off of pressure instead of temperature. Pressure controls have subtractive differentials, similar to their water counterparts. Modulating pressure controls have additive differentials. Most low pressure steam heating systems can operate on 2 to 4 psi. For this example, we will use 4 psi. Other systems should be adjusted accordingly.

On-Off or Low High Off Burners

Set the L404F operating control main scale at 4 psi. Set the differential scale at 2 psi. Set the L4079B limit control to 12 to 14 psi with a 1psi differential.

On a call for heat, the burner will start and run until the steam pressure reaches the L404F's operating setpoint of 4 psi and the burner will shut off. When the steam pressure falls from the main setting by the differential amount ($4 - 2 = 2$) to 2 psi, the burner will restart.

Low-High-Low Burner

Set the operator and limit the same as the On-Off Burner. For this type of operation, an L404F firing rate control must be added to the control sequence. In some cases, as in multiple boiler low-high-low operation, there may not be a L404F low-high-low controller on the boiler. In these instances, low-high-low operation might be controlled by a boiler staging control that is capable of operating low and high fire stages. Typically, for single boiler applications, the firing rate controller is a L404F. Set the L404F for 3 psi with a 2 psi differential.

On a call for heat, the burner will start in low fire and immediately go to high fire until reaching the 3 psi setting of the L404F firing rate controller. When this occurs, the L404F will open its switch, driving the burner to low fire. If the pressure drops below the differential of 2 psi ($3 - 2 = 1$), the burner will drive back to high fire starting at 1 psi.

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Depending on the boiler load, the burner may run between low and high fire without shutting down. This is the desired affect. If the system load decreases to the point where low fire is more than what the system requires, the boiler pressure will rise to the L404F operating control setting of 4 psi and the burner will shut off.

Full Modulation Burners

Set the operator and limit the same as the On-Off Burner. An L91B firing rate control is required for steam burner modulation. Some multiple boiler staging controls can modulate the burner directly, without the use of a L91B control installed on the boiler. Other control scenarios may require a local/remote switch to allow firing rate control from either the boiler staging control, or, in the local position, through it's boiler mounted L91B control. Typically, for single boiler installations, an L91B is used. Set the main scale to 2 psi. This is the minimum pressure setting. Set the differential (proportioning range adjustment) to A (each letter division is approximately 1.8 psi). The control will modulate the burner from 2 to 3.8 psi. The L91B main scale setpoint plus its differential must be less than or equal to the L404F operating controller main scale setpoint. If the system load decreases to the point where the lowest modulation point is more than what the system requires, the boiler pressure will rise to the operating control setting of 4 psi and the burner will shut off.

Low Fire Hold- Water or Steam

Some boilers also use a low fire hold aquastat (Honeywell L4006B). The purpose of this control is to hold the burner at low fire until the setpoint is reached (typically 140°F). Installing a low fire hold aquastat and wiring it into the burner sequence will enable the burner to operate on low fire until an established temperature is reached before moving to high fire. This provides a smoother transition from lower to higher operating temperatures or pressures.

Burner Operating Checkout

Proper control settings are a must in any hydronic or steam heating system and will ensure maximum efficiency. The settings provided above are used as an example; however each installation should be fine tuned to the specific job requirements. Burner operation should be observed after initial control settings are established to check for short cycling or erratic operation from low to high fire. If the burner remains in low fire for extended periods, adjustments should be made. Prolonged operation in low fire can lead to premature burner failure and/or flue gas condensation that can damage the stack vent system.