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Boiler safety controls

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Sorting out which controls do what.



This is a typical boiler installation. Photo credit: Ray Wohlfarth

When looking at a commercial boiler, many controls are mounted on and around it. It reminds me of a Christmas tree with ornaments hanging from it. The function and duty of these controls are sometimes confusing.

Operating control

The operating control is the main control for the boiler. This control will be set for the desired water temperature or steam pressure of the system. In most hydronic applications, the operating control will be set for 180° F. The industry has adopted 180° as the official design water temperature. Heating systems and equipment were designed to operate at full capacity using water at this temperature.

Be careful if the control is set for lower than 140° as the boiler flue gases would condense. Many manufacturers will void their warranty if the boiler water temperature is below 140°. When the flue gases condense, acids are released which will attack the piping, flue and chimney.

On steam systems, the operating control is typically set for 2 psi. The controls should be installed on a siphon or pigtail. This protects the control from live steam by using a water seal.

The operating control is an automatic reset-type control. That means the control will automatically start once the temperature or pressure drops to a predetermined temperature or pressure.

Limit control

The limit control has the same responsibility as the operating control but with two distinct differences. The first is the set point. The set point for the limit control is set at a higher temperature or pressure than the operating control. The other difference is that the limit control is a manual reset control, which means that when the temperature or pressure reaches the set point, it will open and interrupt electric service to the burner. The control will require a button to be depressed to reset the control to allow operation again.

Many installers wonder why the limit control is a manual reset and not an automatic reset control. Consider that your operating control is set at 180° and the limit control is set at 210°. If the boiler temperature raises high enough to trip the limit control, you can be fairly sure that the operating control is not working. The manual reset feature is designed to get someone into the boiler room to investigate.



Pressuretrols determine the operating range of the boiler during the heating cycle.

Modulating control

The modulating control should be set for a temperature or pressure slightly lower than the operating control. For example, it may be set for 175° and the operating control is set for 180°. When the water temperature gets to the modulating control set point or 175° as above, the burner will drop to low fire.

When the water temperature or pressure drops, the modulating control will drive the burner to somewhere between low fire and high fire. Modulating burners are used to better track the temperature or pressure requirements of the building. They also reduce cycling.

Low-water cutoff

The low-water cutoff is the leading mechanical cause of boiler accidents. The low water cutoff is mounted at an elevation above the lowest possible water level of the boiler. On hydronic systems, it is common to have one installed in the piping above the boilers. If the low-water cutoff is connected to the system piping with nipples or pipes, valves cannot be installed in the piping to allow isolation of the low-water cutoff and the system.

Older low-water cutoffs used to use an internal float that would track the water level of the boiler. Many of the newer low-water cutoffs use a probe-type sensor.

Commercial steam boilers require two low-water cutoffs. The primary low-water cutoff on a commercial steam boiler usually has two functions. It is typically referred to as a low-water cutoff/pump control. When the water level drops in the boiler, the first set of contacts will start a boiler feed pump and/or open a feed water valve. If the water level continues to drop, the low-water cutoff will interrupt the electrical service to the burner, shutting it off.

If the level continues to drop inside the boiler, the auxiliary low-water cutoff will trip, cutting power to the burner. The auxiliary low-water cutoff should be a manual-reset style. The auxiliary low-water cutoff will be installed at a lower elevation than the primary cutoff.

Flow switch

Water tube- or coil-type boilers that rely on flow for proper operation use a flow switch instead of a traditional low-water cutoff. Some of these boiler types may be referred to as copper-finned boilers. I prefer a low-water cutoff to be installed in the system piping for these systems even though they are not required for code compliance.

Primary control

The primary control or flame safeguard assures that the burner operates correctly. It will typically be installed inside the burner control panel. Many feature a manual reset switch on the control.



A manual reset control, the limit control's set point is at a higher temperature or pressure than the operating control.

Gas pressure switch

Some boilers require gas pressure switches to meet code compliance. The gas pressure switches are to verify that the gas pressure is within a safe range. If the gas pressure is too low or too high, the burner will not operate correctly.

Several years ago, a main gas regulator failed in Chicago. People were reporting 5-ft-tall pilot flames on their stoves. The high gas pressure switch will be located on the burner head. The low gas pressure switch will be on the gas train downstream of the gas pressure regulator.

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