



Hartford Steam Boiler

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## Boiler Operation and Maintenance: How You Can Help Save Fuel, Prevent Damage, and Avoid Accidents



Most boiler problems don't occur suddenly. They develop slowly over a long period of time. So slowly, in fact, that you grow accustomed to the change without realizing it has taken place. Corrosion slowly builds up in the safety valve. Sediment collects in the float chamber on the connection lines of the low-water fuel cutoff device. Scale accumulates on the waterside of your boiler tubes.

Each year, hundreds of accidents are reported involving steam and hot-water heating boilers in schools, businesses, public buildings, and other facilities. The majority of these incidents are attributed to malfunctioning low-water cutoffs, operator error, poor maintenance, or corrosion. Properly functioning control or safety devices are absolutely essential for any boiler. The only way you can be confident they will work when called upon to do so is to regularly perform required maintenance and testing.

What are these control and safety devices? Some of the more obvious ones are discussed below, with basic recommendations for testing and maintenance. These are not the only items on a boiler that contribute to its proper operation, but they are some of the primary ones. This discussion of testing and maintenance procedures is not

exhaustive — consult with your boiler manufacturer, contractor, insurer, or state boiler authorities with any questions about detailed procedures and requirements.

### Safety Valves

Often considered the **primary** safety feature on a boiler, the safety valve should really be thought of as the **last line of defense**. If something goes wrong, the safety valve is designed to relieve all the pressure that is generated within the boiler. Although it is essential, a safety valve can give you a false sense of security. Keep in mind that the same conditions that make other safety devices malfunction can also affect the safety valve.

Every steam and hot-water heating boiler must have at least one safety or safety relief valve of sufficient relieving capacity to meet or exceed the maximum burner output. The ability of these valves to perform their intended function can be affected by several things, such as internal corrosion or restricted flow, which can prevent the valve from functioning as designed. Internal corrosion is probably the most common cause of "freezing" or binding of safety and safety relief valves. This condition is generally caused by slight leaking or "simmering" due to improper seating of the valve disk. If observed, this condition should be corrected without delay.

**To assure that a valve's mechanism will operate properly, the try-lever should be lifted once a month and the valve set pressure tested annually.** If a valve will not operate or does not reseat properly when tested, the boiler must be shut down immediately and the valve repaired or replaced. The safety or safety relief valve must be set to open at or below the maximum allowable working pressure established by the manufacturer. This is the maximum pressure at which the designers have determined the boiler can be safely operated. The maximum allowable working pressure is listed on the boiler nameplate or stamping.

It is not good practice to operate a boiler too close to the valve setting. Operating too close to the set pressure will cause these valves to leak slightly, resulting in an internal corrosion buildup that will eventually prevent the valve from operating.

## Water Level Control and Low-Water Fuel Cutoffs

These devices often combine two separate functions into a single unit. This method is economical, providing both a water-level control function and the safety feature of a low-water fuel cutoff device. We recommend that both steam and hot-water boilers always have two such devices — a primary and a secondary low-water fuel cutoff. They should be attached to the boiler through separate openings to prevent a restriction in the connecting piping from disabling both devices. Many jurisdictions require two such devices on steam boilers.

**Piping should be kept open and free of scale or sludge buildup at all times.** Properly installed piping will use "cross tees" so the piping can be easily cleaned and inspected. Trouble in piping connections can be easily observed when flushing out or draining the float chamber of the low-water fuel cutoff. The water level should quickly return to normal in the gage glass when the drain valve is closed. A slow return is an indication that the connecting piping to the boiler is restricted.



The most common water-level control and low-water fuel cutoff devices consist of two main components: a float chamber and an electrical switch operated by a float in the float chamber. A malfunction in either will prevent the cutoff device from operating. Malfunctions in the float chamber are generally the result of neglect; tampering and age most often cause failures in the switch and associated wiring.

As the water level in the boiler drops, there is a corresponding drop in the float. When the float reaches a preset position, it activates an electrical switch that shuts off the burner. Sludge and sediment accumulate in the bottom of the float chamber. Failure to regularly flush out the float chamber will cause the sludge to build up, preventing the float from dropping down to the shut-off level. Note that flushing the float chamber should not be considered as a test of the low-water cutoff.

### Be Careful When Testing

During the period when the boiler is operating, low-water fuel cutoffs should be flushed and tested periodically to ensure proper operation. The float chamber on the low-water fuel cutoff should be thoroughly flushed to remove any

accumulated sediment. Since flushing and testing may require lowering the boiler water to the minimum safe operating level, qualified personnel should use extreme caution. Never allow the water level to drop out of sight in the water gage glass. Low-water fuel cutoffs should be flushed daily for steam boilers operating at more than 15 psig and weekly for those operating at less than 15 psig. Be sure the burner stops when the water level drops. If the burner does not stop or the water level does not quickly return to normal, shut down the boiler, investigate the cause of the problem, and correct it.

In addition to flushing the low-water fuel cutoffs, a slow drain test should be done. For all steam boilers, this should be done annually. Hot-water boilers present special problems when doing a low-water fuel cutoff slow drain test. For hot-water boilers, the slow drain test should be done annually but only if this can be done without draining the entire system and without draining considerable quantity of water from the boiler.

At least once a year, low-water fuel cutoff devices should be disassembled, cleaned, and checked. An ideal time to conduct the slow drain test is immediately after this annual maintenance. These devices are an important part of boiler safety. Unless you are thoroughly familiar with them, have an experienced technician perform this type of maintenance.

The electrical switches and wiring are generally quite reliable and require little ongoing maintenance. At least once a year, the switches should be cleaned and any dust or dirt removed. The covers should be kept tightly in place except when opened for cleaning. If used and maintained properly, these switches are virtually trouble-free. However, if abused, they can be a prime cause of boiler accidents. During the annual cleaning, the wiring should be examined for signs that insulation is cracking. All connections should be tight.

### Don't Bypass the Switches

It is not unusual for a maintenance worker to remove the cover and install a "jumper" wire to prevent the switch from operating. This starts out as a temporary convenience, often to "fix" a boiler that keeps shutting off on low-water while being operated at high demand or as a temporary means to test other circuits in the control system.

This bypass can easily become a permanent and dangerous condition. A boiler that regularly shuts down indicates a very serious problem that could lead to a catastrophic accident. A jumper wire should never be permanently installed in a low-water device. Only a qualified technician should use a jumper to test another circuit.

### The Fuel System

**The fuel system, particularly the burner, requires periodic cleaning and routine maintenance.** Failure to maintain the equipment in good working order could result in higher fuel costs, the loss of heat transfer, or even a furnace explosion.

Modern fuel systems are very complex assemblies, consisting of both electronic and mechanical components. Over a period

of time many things may go wrong — ignition transformers deteriorate or fail, ignition electrodes burn and become coated, fuel strainers and burner equipment become clogged, fuel valves become dirty and leak, air/fuel ratios drift out of adjustment, flame scanners become dirty. Many users wisely contract with their gas company or oil service company to periodically check and maintain their burner equipment.

Properly maintained equipment should be safe and reliable, but devices installed to assure safe operation are sometimes viewed as an inconvenience. The personnel who operate the boiler may tamper with or adjust these devices, thereby compromising safe operation of the boiler.

The safety feature most often adjusted is the burner purge cycle, designed to prevent furnace explosions caused by a buildup of unburned fuel in the furnace chamber. The cycle length is determined by the equipment manufacturer to purge fuel from a leaking fuel valve or an unsuccessful ignition sequence. It is annoying to have a boiler fail to ignite and then wait for the burner to go through another complete purge cycle. You may be tempted to shorten or even bypass the cycle. **Don't!** Doing so greatly increases the chances of a serious furnace explosion.

## The Water Gage Glass

The importance of proper cleaning and maintenance of the water gage glass, or sight glass, cannot be stressed enough.

The water gage glass on a steam boiler enables the operator to visually observe and verify the actual water level in the boiler. **If not properly cleaned and maintained, a gage glass can seem to show there is sufficient water, when the boiler is actually operating in a low-water condition.** A stain or coating can develop on the inside of the glass where it is in contact with boiling water. After a time, this stain gives the appearance of water in the boiler, especially when the glass is completely full or empty of water.

Clogged connection lines to the gage glass is another indirect cause of accidents. In that case, the gage glass may show normal water levels while in fact the water level may be low. **The piping connecting the gage glass to the boiler should be cleaned and inspected regularly to assure it remains clear.**

One final problem should be mentioned. Often, a boiler is operated with the isolation valves to the gage glass closed because the glass has been broken, or is leaking. Take the time to replace the glass, even if the boiler must be shut down. That inconvenience is nothing compared to the damage that may result from operating a boiler without a gage glass. Some operators routinely replace the glass and seals during annual maintenance because it is so important to verify the actual water level.

## The Stack Temperature Gage

A stack temperature gage is normally installed on a boiler to indicate the temperature of the flue gas leaving the boiler. A high stack temperature can be an indication of boiler tubes fouling with scale and/or soot. The stack temperature can also be impacted by a deteriorated or burned baffling inside the boiler (which allows gases to bypass heat transfer surfaces in the boiler), or an out-of-adjustment burner. These conditions generally develop slowly over a long period of time, slow enough so the person who operates the boiler can become accustomed to the gradually rising temperature. Approximately 1 percent in boiler thermal efficiency is lost for a 40-degree F increase in stack temperature.

## Boiler Logs Are Important

The majority of boiler accidents can be prevented. One of the most effective tools is the proper use of operating and maintenance logs. **Boiler logs are the best method to assure a boiler is receiving the required attention and provide a continuous record of the boiler's operation, maintenance, and testing.** Because a boiler's operating conditions change slowly over time, a log is the best way to detect significant changes that may otherwise go unnoticed.

If a boiler is to be kept in good operating condition, someone who tends to the boiler must be responsible for its operation and maintenance. This person should have a good understanding of boiler operation and safety devices. Maintenance and testing should be performed and recorded in the log on a regularly scheduled basis. The responsible individual should initial the log to verify each operation performed, who performed it, and when it was done.

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