

Boilers: Dry-Firing



The Dry-Firing Problem

Cast iron heating boilers are robust pieces of equipment that, when well maintained, can provide many years of reliable service. Well maintained cast iron boilers can last 35 years or more¹. If the manufacturer's recommended maintenance schedule is not followed, the result can be a catastrophic failure of the boiler.

Since dry-firing is a covered cause of loss under many boiler and machinery insurance policies, many boiler losses are claimed as dry-firing. Often, we find that is indeed the case, but not all boiler leaks are caused by dry-firing. This white paper will discuss some of the common causes of dry-firing in sectional cast iron boilers.

Sectional Cast Iron Boilers

Sectional cast iron boilers are popular because of their robust design, relatively easy installation, and scalability. Individual sections are bolted together and paired with a burner that can either be located underneath the sections or mounted to the side of the boiler. In either case, the flames and hot combustion gasses travel between the cast iron sections, heating the metal and water contained inside the sections. This type of boiler can be configured to provide hot water or steam, depending on the requirements of the building's heating system.

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Low Water Cutoff Switches

Radiant heating systems (steam or water) contain complex systems of pipes, fittings, coils, radiators, etc. throughout the building. As such, leaks are bound to occur, especially in steam systems. When water or steam leaks out of the system, make-up water must be added to maintain a minimum safe water level within the boiler.

In order to ensure that the minimum safe water level is maintained, a combination of low water cutoff switches and automatic water feed devices can be used. Boiler dry-firing is generally caused by a failure of these devices which allows the water level to drop, thus allowing the cast iron to overheat and crack.

Figure 2: Float style low water cutoff switch that failed due to excessive build-up of sludge



Failures of Low Water Cutoff Switches

Sediment and sludge naturally build up inside boilers at varying rates based on many factors, including the quality of the incoming water, rate of make-up water, chemical boiler treatments, condition of the distribution system, etc. The water inside the float chamber of a low water cutoff switch is relatively stagnant, so these chambers are prone to fouling due to a build-up of sediment. If sediment is allowed to bridge the gap between components of the float or the float and the chamber, the float can stick, thus causing the switch to read a normal water level when it is actually low.

Float style low water cutoff switches can also fail if the equalizing piping which connects the switch to the boiler becomes plugged with sediment. This can cause water to remain in the float chamber even when the boiler level is low.

Probe style cutoff switches are subject to failure if sediment from inside the boiler bridges the gap between the probe and the boiler shell. If this occurs, the sediment can create a conductive path mimicking the presence of water.

Boiler dry-firing can be prevented by following the manufacturer's recommended maintenance procedures.

When the low water cutoff devices fail, it can cause the boiler to run low on water. The boiler is designed for a certain minimum water level inside the sections. If the water level drops, the remaining water absorbs less heat from the cast iron, thus causing the temperature of the cast iron to rise. If not caught in time, the temperatures can rise to the point of failure of the cast iron. Another common failure mode is the thermal shock caused by a sudden influx of make-up water to a hot boiler. This causes rapid contraction of the cast iron which can cause it to crack.

Failure Prevention

Boiler dry-firing is preventable with adequate maintenance of the boiler and low water cutoff devices. It is highly recommended that all steam boilers be installed with two low water cutoff devices, one to trigger the make-up water supply, and a second to shut the boiler down in the event of a failure of the main device.

Float type low water cutoff switches must be "blown down" on a weekly basis whenever the boiler is in operation. Manufacturer recommended maintenance schedules should always be followed, including an annual cleaning. Low water cutoff switch manufacturers also recommend replacement of various components or the entire device at various intervals.^{2,3}

Claim Evaluation

A leaking boiler does not automatically equate to dry-firing. Careful inspection of the cast iron sections must be made, along with the low water cutoff devices in order to make a proper determination. Boiler repairs in many cases are performed on an emergency basis and can't wait for inspection. In these cases, all boiler components should be saved for later inspection, and the low water cutoff devices should be removed without opening the switch. Amset can then perform a complete investigation in order to determine if the damages are due to dry-firing, oxygen contamination, wear and tear, or another cause. Amset can also determine if the boiler is repairable and review the claimed costs for reasonableness.

References

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3. McDonnell & Miller, "Instruction Manual MM-216K," <<http://documentlibrary.xylemappliedwater.com/wp-content/blogs.dir/22/files/documents/2012/04/MM-216K.pdf>>

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