

Boiler & Pressure Vessel Inspection discrepancies and failures



Water Heaters / Pressure Vessels

- Pressure Vessels are inspected once every three years. This requires a test of
 - A: safety relief devices
 - B: Temperature and Pressure controls
 - C: External exam to check for leaks
 - D: Testing to verify thickness of the vessel body

Basic Thermo Dynamics of water.

- Water boils at atmospheric pressure (14.7psi) at 100 deg. C or 212 deg. F.. When placed under pressure water can be heated to extremes without flashing to steam.
- The typical expansion rate for 1 cu. ft of water is 1700 cu ft. of steam.

Relief valve installed backward on a 119 gal. electric water heater. With inlet and outlet stamped into the valve.



Failure of Normal Operation

- If the relief valve does not properly function and the temperature control fails to properly control temp. The water heater will heat unchecked until catastrophic failure occurs.
- The routinely inspected water heater holds 119 gallons, there is considerable explosive force behind such a release of energy.

This is the result of a relief valve failing to lift on a 119 gal. water heater in a split level home.



**Multiple family dwelling in
Mifflinburg PA. Relief valve failed to
function, Water Heater was in the
basement**



Routine Maintenance and inspections on Low Pressure Boilers

Low Pressure Boilers are inspected annually while in operation and internally every 3 years, if construction permits.

During this inspection all safety device function is evaluated, relief valves, Low water fuel cut outs, high temperature and high pressure switches.

The following photos are of a Maine boiler that failed due to mechanical issues stemming from lack of proper maintenance

- This boiler was added to the inspection route days before this incident. This was the initial inspection to place it in the system
- What follows is the list of items noted during the inspection.

Items noted on the inspection prior to failure

- A: Low water cutout both left and right sides failed to initially function. Units required multiple flushing to function.
- B: Relief tested and leaking steam from spindle
- C: Gage glass scaled, can not read water level within boiler
- D: Bottom connection on right side low water cutout corroded and leaking water
- E: Steam and water connections on water column leaking
- F: Left side mud drum **water supply** piping heavily corroded and steadily leaking water
- G: Left side mud drum, 3 mud drum to boiler connections heavily corroded and leaking
- H: Check burner operation and combustion system tuning, heavy puff of smoke on ignition of burner.

It is suspected that in the night the left side mud drum water supply connection that was corroded and leaking failed along with the low water cutout switch.



Left Mud Drum Water Inlet connection



These failures allowed the boiler to continue to operate without a cooling medium. Allowing the unit to overheat to the point of rupturing the left mud drum and burning off the electrical wires from the safety shutoff connections at the front of the boiler



Top right in photo is the point where the safety switches wiring connected to the burner controls

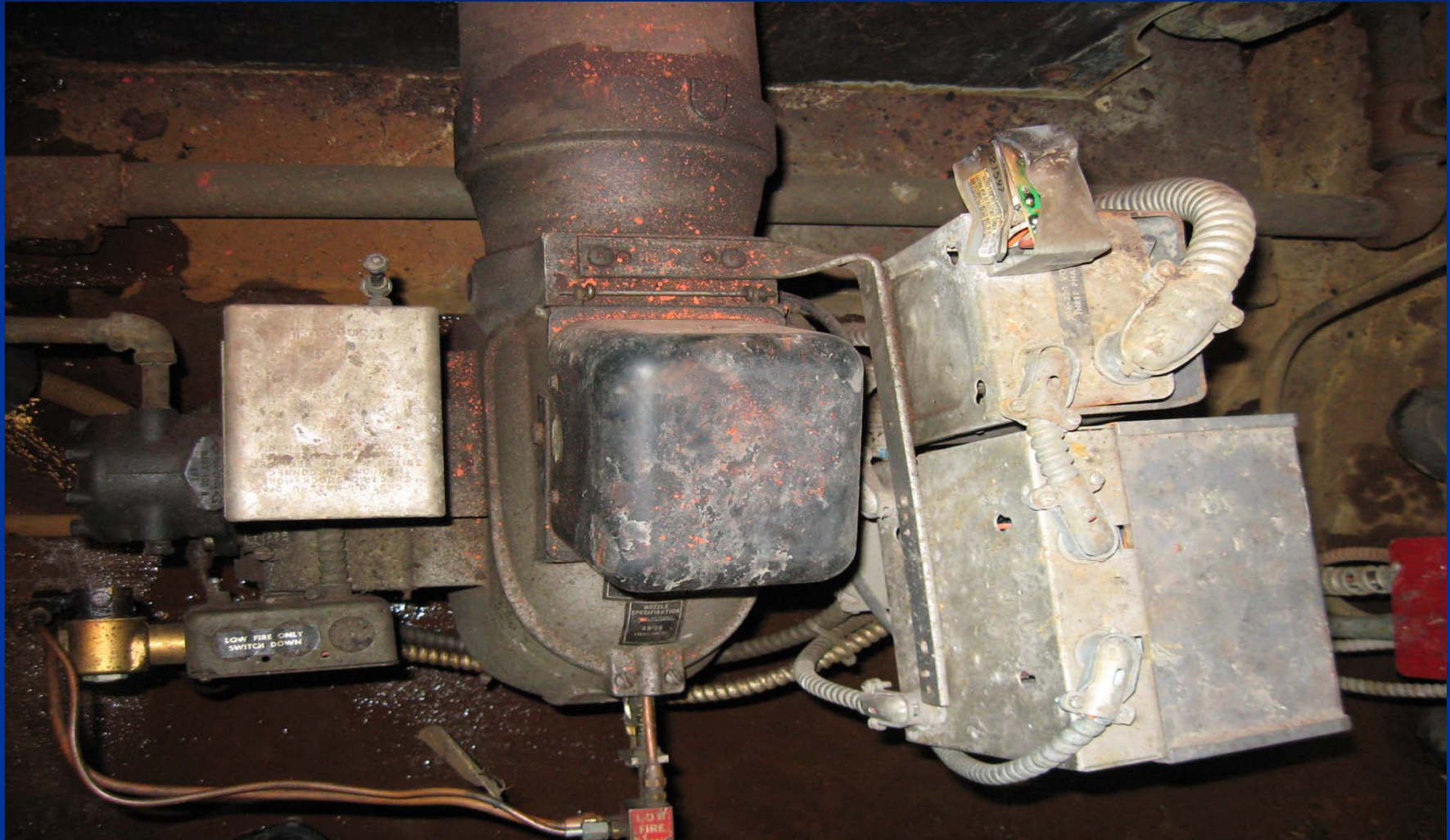


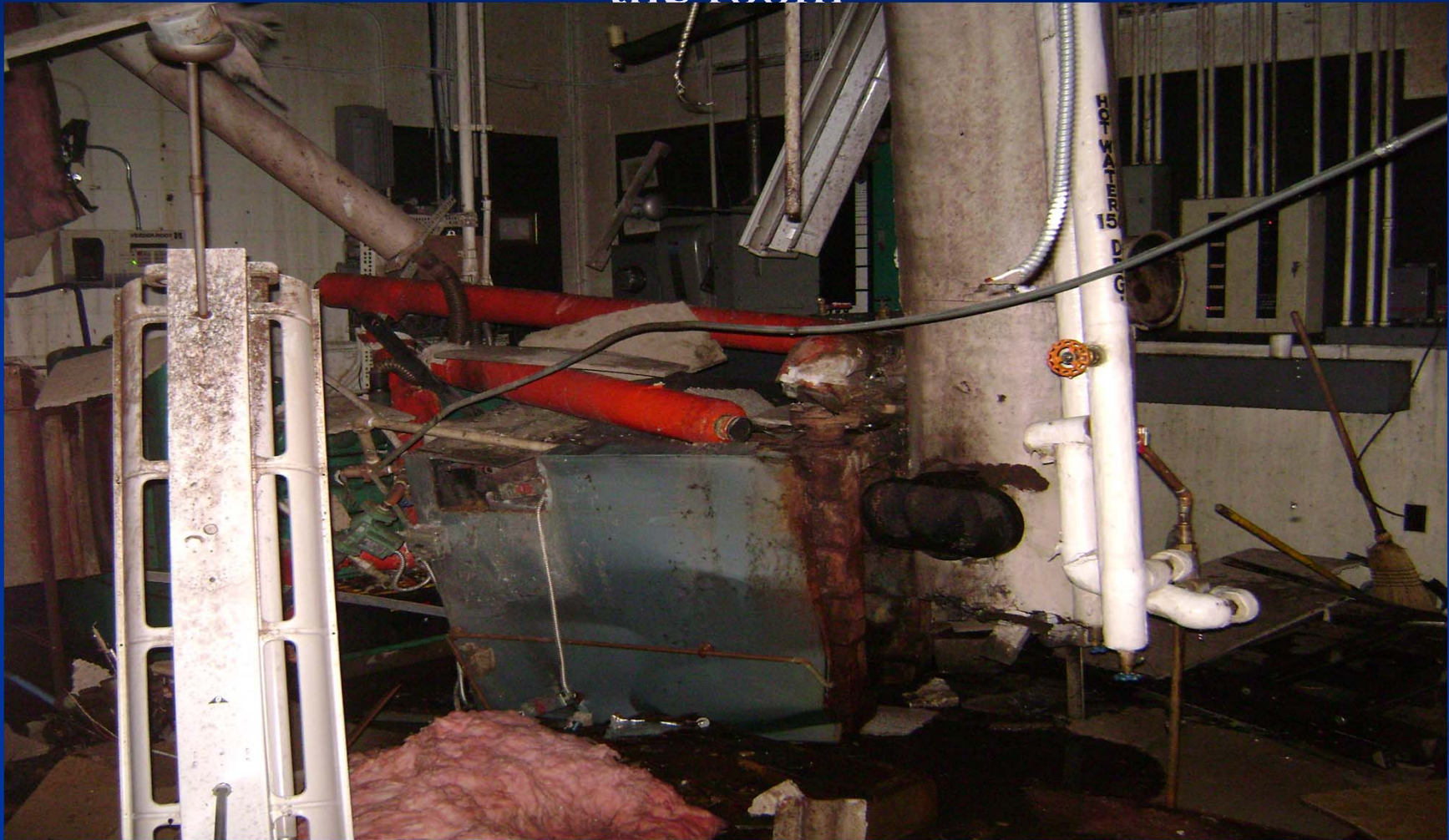
Photo of the over heated firebox. No one was injured in this event. Even though the boiler was found running in this condition in the morning.



Hot Water Heating Boiler failure due to non functioning low water cutout

- This was a domestic or residential size hot water heating boiler used for building heat.
- This was a Federal Facility located in Maine in which the State of Maine has no jurisdiction. This boiler does not require inspection per Maine law
- Failure of the Low water fuel cutout safety switch was root cause
- Incident occurred after normal working hours, no individuals were injured.

Boiler lying on its side where it landed after the explosion. Significant damage is evident throughout the room



Ceiling of the room where the boiler hit when it lifted from the floor



Exterior of the building damaged by the blast.
The boiler was located in the basement.



**Low Pressure Steam heating boiler installed in Maine.
Inspection noted, leaking sections, a rusted out condensate
return line and improperly operated boiler**



Securing and opening the steam heating boiler found the boiler full of calcium hardness and scale. As the unit heated, the calcium hardness expanded and pushed the sections apart causing leakage



Condensate return line that should have been returning reclaimed water to the boiler was pouring on the floor due to rusted out piping.



With lack of blow down, nearly 100% make up, and lack of proper operation and service this unit pushed itself apart. These units are serviced on an annual basis by properly licensed technicians



The following photos are of boilers and items found during routine annual inspections of low pressure boilers in Maine.



Corroded water inlet line. Incident waiting to happen



Mud Drum to Boiler connection, corroded and leaking.



Corroded mud drum and boiler connections. Hazard is boiler explosion.



Leaking and corroded safety valve.



Discolored lagging top left and bottom background is soaked with fuel oil from a leaking fuel oil supply fitting.



Hot Water system circulating pumps corroded and leaking inlet and outlet connections



Bad refractory causing hot spots and fire hazard along with bad door seals allowing CO into the building



**Missing insulation causing fire hazard,
and allowing exhaust gasses into the
building**



Bad door gaskets creating fire hazard, heat damaged pipe insulation, exhaust gasses allowed into building.



Domestic hot-water heating boiler in NJ. Came up through the floor, out the side of the house and....



Into the neighbors house 60 feet
away.



One individuals solution to a leaking relief valve.
Last resort? Place an isolation valve in the system.
Refer back to the 119 gal water heater.



Boiler explosion caught on video in Maine. Note the items on the desk bottom right. These 3 photos watched in series will show the first few seconds of a boiler event



The operator had just exited the scene heading to the left. Note fireball top of the screen, burner on front of boiler twisting to the right, ladder twisting and items lifting of the desk bottom right



These 3 photos were taken from a continuous feed video. Elapsed time is split seconds .



A situation where an air tank had been welded in place of a Steam Jenny Boiler and used for thawing culverts by a Public Works dept in Maine. This is not built to code.



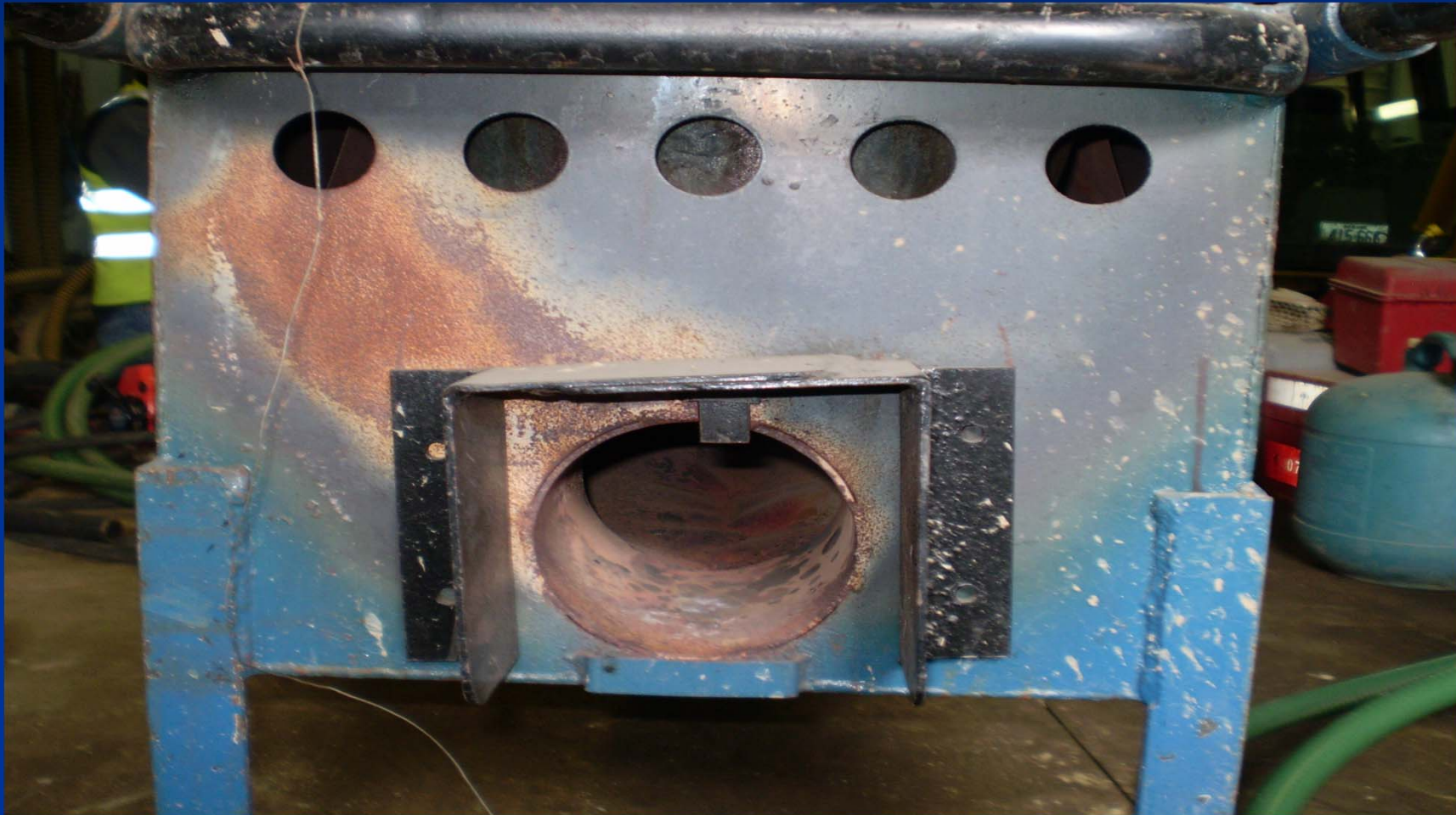
The vessel is clearly ASME stamped U, non fired pressure vessel, max temp 650 deg. F.



It had been fitted with a hot water boiler relief valve not a steam safety valve, was manually filled with 5 gallons of water



Then a gas rosebud torch was placed underneath the vessel to boil the water and bring the pressure to 15 psi. At that point they would open the isolation valve and force steam into frozen culverts. The perfect IED



The gas bottle and rosebud torch
used to bring the vessel to a boil.



In Closing

- There are many, many more pictures to show, we are limited only by time. We have situations where no one is monitoring the boiler in schools and municipalities on a regular basis. Sometimes the inspector is the only individual looking at the boiler. There have been instances where a school has needed to be closed early due to conditions found during the inspection. In this case relief valves on two water heaters and the heating boiler were found to be non-functioning.

Frequently noted items

- Low water fuel cutouts, stuck safety and relief valves in day care buildings on college campuses.
- Due to these units not requiring annual inspection by State of Maine Law, controls and safety devices such as low water fuel cutouts, high temperature and high pressure switches are often found not installed to current requirements.
- These items were found during consult inspections as requested by Risk Management

Routine annual heating boiler maintenance.

- Most owners are under the assumption that the technician servicing their boiler on an annual basis is somehow taking care of the testing of devices and inspection. This is not always the case. This service normally entails servicing the combustion and burner fuel systems, change of fuel filters, clean the fuel pump housing, nozzles, check the igniter, vacuum the gas passes of the boiler and perform an efficiency test of the unit, etc.
- An evaluation of the pressure containing capability of the boiler is not made. That is the primary purpose of the annual boiler inspection.

Inspections

- Routine inspections are considered critical to ensure proper safety of the boiler.
- The inspector may be the only one to look at these boilers. If conditions go un-noted it may lead to catastrophic results.
- This is why we do inspections.