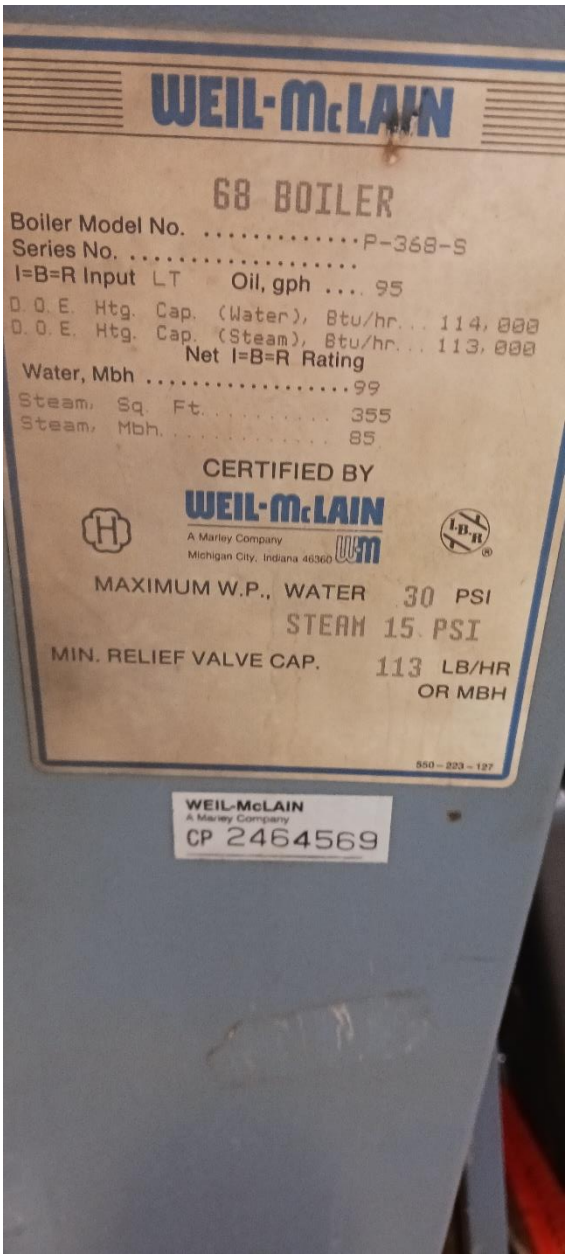

Figure 1 Weil McLain Boiler Plate. Installed in 1994 by Augustitus Plumbing, Little Falls, NJ

Figure 2 Fireside joint failure. Long region of inter-section sealant allowed combustion smoke to escape the combustion/flue passage and into the room. Smoke residue is apparent on middle boiler section and adjacent Cover Plate for Heater Opening (Rectangular.) Middle boiler section (A) is misaligned with the front and back sections. Bead of sealant between front and middle section remains mostly intact. This condition started very early in the life of the boiler but was only noticed on a poor ignition instance. There was only ever a puff of smoke that escaped at ignition and a nearby smoke detector about the boiler never detected smoke.

Figure 3 Disassembly of sheet metal shroud. *Removal of a few sheet metal screws and alteration of one back section enabled the shroud to be easily removed. Removal of the burner and controls was necessary to remove the front panel, though it was learned that was not necessary for this repair.*

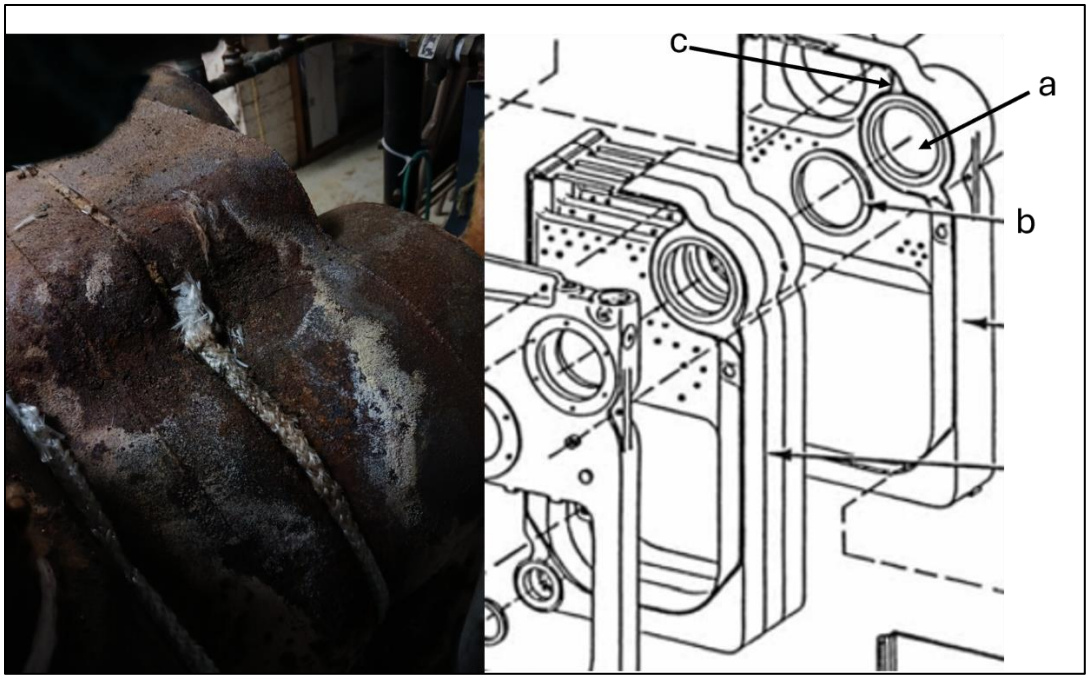

Figure 4 Early evidence of leakage. *Ceramic rope was mistakenly packed into the region between the sections around the water heater chamber (a), thinking that smoke was escaping from the joint. The staining was in fact tracks of steam leaking past the 6" internal elastomer seals (b). It was later learned that the internal flue seal turned to the inside of the section that isolates the heater chamber (c). The placement of the rope seal in the region shown was a mistake.*

Figure 5 Boiler Front. *The fire box was significantly deteriorated (not shown). Evidence of steam or condensate infiltration (a.) The boiler was deemed no longer usable and was taken out of service.*

Figure 6 Boiler side view. *¼" ceramic rope (measured closer to 3/8") was packed into gap (a) between the rear and middle sections. By stretching the rope and forcing it with a putty knife, the rope was neatly emplaced to seal off combustion gases. This step was taken to seal off escaping flue gases before the steam leak on the opposite side was discovered.*

Figure 7 Boiler rear section. *The rear section was isolated from the existing piping by cutting a 1-1/4" copper condensate return pipe leading to the 2" main boiler port. This rear section was too big and heavy to remove from its location on the pillow block. The best that could be done to facilitate movement of the section was a come-a-long secured to the ceiling joists above the boiler. At times, the section was tilted backward to rest on the bottom blow-down valve. Solenoid for automatic water fill valve is shown (lower right.)*

Figure 8 Evidence of steam leak. *Ceramic rope mistakenly packed into gaps between sections. ½" tie rod shown near the top. There is a 3/8" tie rod on the opposite side of the heat exchanger cavity.*

Figure 9 5/16" tie rod. *This rod would have been exposed to steam causing the nut to seize onto the threads. Not much torque occurred before the rod sheared at the nut. There was no split-lock washer on the tie rod.*

Figure 10 Tie Rod Removal Preparation *Rachet tie down was used to ensure the sections would stay together as the tie rods were removed. A ¾" socket on a ½" breaker bar was used to loosen the nut on one end of the rod. The rod was in good condition so it was ultimately reused.*

Figure 11 Lower waterside tie rod. *Water immediately leaked out of the joint when the rod was loosened. Once the rachet tie strap was loosened, the boiler sections separated without much more than by one hand.*

Figure 12 Rigging the middle section. *Using a Maasdam come-along, the middle section was easily lifted out of place. It was heavy but could be lifted on to a nearby work bench by hand. Most of the rehabilitation and preparation was done on the middle section. With some care, the section was moved in and out of the assembly without using a come-along. The front section was still piped to the main header and remained in position throughout the rest of the rebuild.*

Figure 13 Waterside joints. *The seal glands and opposing faces of the water section joints were found to be in very good condition. Though they look rough in these photographs, they cleaned up easily to almost new condition. The 3" elastomer are still emplaced in their glands.*

Figure 14 Restored waterside-joint face. *The faces of the section joint were all very near perfect. A file and emery cloth were used to remove and deposits and clean the surfaces. A minor amount of corrosion was located to the inside diameter of the elastomer seal, otherwise, the surface was intact.*

Figure 15 Steam side joints. *The steam side joints were moderately compromised (a.) Both 6" elastomer seals had varying degrees of deterioration and lamination (b), causing corrosion of the glands but not on the opposing faces. A layer of the seal shown in (b) transferred to the opposing face (c). This evidence leads to the cause of failure where steam corroded the interface of the seal and gland and eventually eroded a path of escape. Corrosion of the glands was in a 20º arc and less than 0.020" deep at any point. The elastomer seals (d) were easily removed. They were still supple though not usable. It was a short path for steam to escape to the outside of the boiler (e) or to the inside (fireside) (f). The flue seal, part cement and rope were completely missing around the heater cavity. A fair amount of work was done to restore the groove that would seat the ¼" ceramic rope.*

Figure 16 Restored section glands. *The glands and faces were restored mostly with hand tools. The most effective to for removing rust, scale, cement and cording was a ¼" wood chisel. It fit nicely into the gland and easily cut through any buildup. Pitting in the bottom of the gland was limited to a 20º arc and filled with JB Weld Steel epoxy. The restoration was better than represented in these photos. A very small void (a) was subsequently filled with another application of JB Weld. A steel file was used to dress across the surfaces. Most of the gland surfaces were very slightly damaged with only surface corrosion as seen in images 3 and 4. The planned sealing procedure was to use Permatex Red high temperature gasket material to seal all surfaces and create an adjunct gasket for the elastomer seals. The Permatex was painted on all mating surfaces with a thin layer using a small artist brush (stole from wife's art kit). The Permatex also provided a good slip layer during assembly to allow easy section alignment.*

Figure 17 Reassembled boiler sections. *A small amount of Permatex gasket material squeezed out of the 6" upper joints(a). Tie rods were torqued to 50 ft-lb for the ½" rod (as per Weil-McLain technical support) and 25 ft-lb for the 3/8" rod (as per calculated yield for carbon steel.) Sections were allowed to rest for 24 hours then re-torqued with some tightening. After another 24-hour relaxation, no further tightening occurred at torque values. After three practice dry assemblies, it was learned that the ceramic rope was impeding the 6" rear/middle sections from mating. A length of rope (b) was eliminated from the assembly to allow the sections to mate. The gap (c) was later filled Rutland 2000ºF furnace cement. Both joints were then covered with cement (not shown.) Boiler was hydrostatically tested to 4 psi for 24 hours with no leaks. Boiler was tested to 2 psi steam pressure with no leaks (water or smoke). Boiler cycled several times and has been at rest for 5 days without leaks.*