

## Incident Summary #II-1502482-2023 (#31134) (FINAL)

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|---------------------------|--|--|---|
| SUPPORTING INFORMATION    | Incident Date  | January 30, 2023   |   |
|                           | Location   | Quesnel  |   |
|                           | Regulated industry sector  | Gas - Natural gas system   |   |
|                           | Impact   | Qty injuries   | 1   |
|                           |  | Injury description   | Smoke inhalation and burns on the hands   |
|                           |  | Injury rating  | Minor   |
|                           | Damage   | Damage description   | The boiler had a hole through the metal fan coupler and was removed from service permanently. There was burn damage to the boiler venting and plywood wall behind the boiler. |
|                           |  | Damage rating  | Moderate  |
| Incident rating           | Moderate   |  |   |
| Incident overview         | A natural gas fired water heating boiler in service for over 15 years developed a hole in the burner allowing flames to enter the premix area above in the fan coupler. After a smoke smell was noticed during the night, a resident found the boiler with fire emitting out of a hole that was blown in the metal fan coupler at the top of the boiler. |  |   |
| INVESTIGATION CONCLUSIONS | Site, system and components  | <p><b>Site and system</b></p> <ul style="list-style-type: none"> <li>The residential home uses a natural gas fired boiler for heating water.</li> <li>The boiler uses the combustion of natural gas to heat water which is circulated to radiant floor heating within the home.</li> </ul> <p><b>Boiler components</b></p> <ul style="list-style-type: none"> <li>The boiler uses a metal fan coupler to connect the fan to the boiler chamber.</li> <li>The fan premixes intake air with natural gas for the appropriate mixture to be ignited by the ignitor in the combustion chamber.</li> <li>The burner mesh facilitates even dispersal when the gas/ air mixture enters the combustion chamber. A clean burner helps to ensure the flame pattern is evenly distributed over the burner surface and when intact prevents flames from entering the premix area.</li> <li>The ignitor is a single prong ignitor that arcs to the grounded burner mesh in the combustion chamber.</li> <li>The heat produced by the boilers transfers to the water without direct contact by way of the heat exchanger.</li> </ul> <p><b>Boiler venting system</b></p> <ul style="list-style-type: none"> <li>The boiler uses a fully enclosed polyvinyl chloride (PVC), category 4 venting system to exhaust the products of combustion to the exterior of the residence with the assistance of the boiler fan.</li> <li>The venting air intake is a direct vent type that supplies air to the boiler from outside the building.</li> </ul> <p><b>Boiler manual</b></p> <p><i>The boiler manufacturer's installation manual includes the following related items:</i></p> <ul style="list-style-type: none"> <li>Inspection of the boiler to be performed annually by a qualified service technician.</li> <li>Visually inspect burner through sight glass. Ensure flame is stable and without excessive fluttering. Normal flame pattern is evenly distributed over the burner surface. If burner is operating improperly, remove and clean or replace. Use CO<sub>2</sub> (carbon dioxide) analyzer to determine proper</li> </ul> |   |

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|                            | <p>combustion. CO<sub>2</sub> level should be 9.2% for natural gas.</p> <ul style="list-style-type: none"> <li>• In the troubleshooting section under ignition problems, it states:             <ul style="list-style-type: none"> <li>○ If the boiler rumbles when igniting to do combustion analysis and check gas input and output pressures to rectify the issue.</li> <li>○ If it is noisy when igniting to ensure the ignitor probe is dry by running a purge, clean it or replace to rectify the issue.</li> </ul> </li> </ul>   |
| <p>Failure scenario(s)</p> | <p>The water heating boiler was produced in 2006 and installed in the residential home in the next year or two. In late 2008 there were two service visits by a technician from a gas contractor which included replacement of some boiler water system components. After the boiler had been in operation for roughly five years, in 2012 a technician for a gas contractor was called to site to troubleshoot a noisy combustion motor for the boiler. They did so by replacing the combustion motor, cleaning the burner, cleaning the ignitor, cleaning the exhaust vents, and cleaning the heat exchanger. There were two visits by technicians from a gas contractor in 2013 where the flame sensor was replaced and then later cleaned.</p> <p>Over the next roughly ten-year period there were numerous visits by gas contractor technicians. The records indicated these visits mostly involved issues with the radiant water heating system. There was a report of the boiler making noises in 2015 that were not able to be duplicated when the technician was on site. In 2016 a gas contractor technician recorded the boiler had banging noises and numerous error codes during a site visit. The technician cleaned the condensate trap and the pump and placed the boiler back in operation. The boiler manual indicates remedies for when the boiler rumbles during ignition is to perform gas pressure tests and combustion analysis. There was no evidence that gas pressure tests or combustion analysis tests were performed in response to the boiler banging noises.</p> <p>For most of the boiler's lifecycle based on the available records, it went without maintenance or cleaning of the boiler's burner and without overall assessment of the combustion system. This included over the ten-year period leading up to the incident. During this time there were indicators that there were issues with the combustion including banging noises that were not resolved. There was no record of gas pressure tests, combustion analysis, or other diagnosis during site visits or in response to the combustion issues over the majority of the lifecycle of the boiler. Most service activities were to deal with specific issues affecting water heating without identification of any underlying issues with the boiler combustion system or its integral components.</p> <p>After over ten years with no cleaning or replacement of the burner, a hole was burnt through the burner mesh where deposits had accumulated. Once there was a hole in the burner, flame was able to enter the premix area in the fan coupler. The heat and pressure from gas igniting inside the fan coupler eventually broke through the fan coupler emitting fire out from the combustion chamber.</p> <p>At 4am on the day of the incident one resident noticed the smell of smoke. The other resident went to the basement where the boiler was and saw flames coming out of the top of the boiler roughly two feet high. The fire department was called in and while waiting an occupant used buckets of water to knock down the fire and removed some ceiling tiles that were directly above the fire. The occupant had smoke inhalation and burns on the hands.</p> |

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### Facts and evidence

#### Site findings

- During assessment, when a flashlight was placed inside the removed burner, the burner mesh was found to be clogged as shown in ([Photo 3b](#))
- The burner mesh was quite dirty.
- There is a hole in the fan arm (coupler).
- There is an area of the boiler mesh that is open or burnt.
- The burner seam was installed in line with the ignitor against manufacturer instructions. The hole that developed in the burner mesh was on the opposite side from the ignitor and seam, so this was likely not a factor in the burnt hole.
- The boiler involved with the incident did not have the retrofit top high limit installed under the manufacturer's bulletin/ recall, see below for more information ([Photo 7](#)).

#### First contractor correspondence (referred to as Contractor A)

##### *Summary of Contractor A correspondence*

Contractor A invoices showed that their technicians had been to site various times between 2008 and 2020. Most of the service work was related to getting hot water running to the radiant floor system. This included cleaning out clogged portions of the water system such as the pumps, manifolds, and branches. In 2012, after finding a noisy combustion motor, the boiler had the burner head and ignitor cleaned, and the heat exchanger cleaned. On two occasions in 2013 the flame sensor was cleaned. While there was some boiler combustion related maintenance in those earlier years, beyond 2013, roughly 6 years into the service life of the boiler, there was no regular maintenance of the boiler combustion chamber and components on record. A 2015 site visit involved boiler noises and then a 2016 site visit involved the boiler banging with numerous error codes. The invoices for these visits did not show any combustion analysis records, boiler, gas, or ignition related service or maintenance items, only items related to the water system. There was no record that the burner mesh was ever replaced since original installation in 2006 or cleaned after 2012. The incident occurred over ten years after the burner mesh was last cleaned.

##### *Invoices and information*

- Is a licensed gas contractor in BC.
- A November 2008 invoice from gas Contractor A, stated "inspecting IBC boiler, all components and zones working. Replaced supply & return sensors on boiler. Complete."
- A December 2008 invoice from gas Contractor A stated, "inspected boiler, heat is on & working when technician left", as well as some radiator work.
- An October 2012 invoice from gas Contractor A stated "Checked boiler – combustion motor is noisy. Removed burner head & cleaned. Cleaned coils inside heat exchanger, cleaned ignitor sensor & exhaust vents. Tested – unit fired after 5 tries. Replaced combustion air motor & ignitor sensor. Complete."
- A March 2013 invoice from gas Contractor A stated "Inspected boiler. Cleaned inside of unit & cleaned flame sensor. Boiler pressure was down, filled through auto fill valve by hand. Replaced burner flame sensor & inducer fan. Tested – good. Complete."
- An October 2013 invoice from Contractor A stated "Checked boiler.
- Checked flame sensor & cleaned it."
- A January 2015 invoice from Contractor A, a call out to site seemingly related to a reported boiler noise, stated "Boiler would not make any noise while tech was there. Note: Topped up the water pressure. Boiler feed valve is not working properly and is need of replacement."

## Incident Summary #II-1502482-2023 (#31134) (FINAL)

- A November 2015 invoice from contractor dealt with radiator system and pumps servicing by two technicians over a few days of site visits. The invoice did not include any boiler, gas, or ignition related items.
- December 2015 and January 2016 invoices from Contractor A both dealt with leaks from the plumbing system. The invoices did not mention any boiler, gas, or ignition related service or maintenance items.
- A March 2016 invoice from Contractor A stated, “Boiler is banging and there are numerous error codes. Inspected boiler, condensate trap was plugged with grit. Pump is plugged with rust scale. Cleaned both, filled & tested – OK. Complete.” The invoice did not mention any boiler, gas, or ignition related service or maintenance items.
- A March 2017 invoice from Contractor A dealt with an error code and the boiler not building water pressure and no hot water or heat. A water leak was found at a water pressure sensor. The failed pressure tank was replaced. The invoice did not mention any boiler, gas, or ignition related service or maintenance items.
- An April 2018 invoice from Contractor A dealt with pressure tank and water related items. The invoice did not mention any boiler, gas, or ignition related service or maintenance items.
- A July 2019 invoice from Contractor A dealt with an issue of no heat or hot water. The invoice mentioned a boiler error code. A motor, control and sensor were ordered and installed and the boiler “seemed to be working”.
- An August 2019 invoice from Contractor A dealt with repairing a leak in stainless weld. The invoice did not mention any boiler, gas, or ignition related specific service or maintenance items.
- In December 2020, gas Contractor A was called to site and did some repairs to a water leak from the boiler system water lines. The contractor invoice stated, “would recommend regular servicing on unit.” The invoice did not mention any boiler, gas, or ignition related specific service or maintenance items.
- After the December 2020 site visit, they were not back to the site again.

### **Second contractor statements (referred to as Contractor B)**

#### *Summary of Contractor B correspondence*

Contractor B originally installed the boiler at the site as a gas fitter for Contractor A. Contractor B described cleaning the boiler burner over ten years before the incident. Contractor B had been doing some work on the radiant water heating system for the owner in the months leading up to the incident. The recent work did not involve work as a gas fitter or on the gas system and was not related to Contractor A.

- Formerly worked for Contractor A and originally installed the boiler system at this site.
- Is a gas fitter but doesn't do gas fitting work anymore.
- Not licensed or bonded, could still do gas work under a licensed gas Contractor But doesn't.
- Had never change the burner out but had removed and cleaned it before retiring over 10 years before the incident. Contractor B brushed it with a soft cloth, and it was clean at that time with no damage visible.
- Was on site in December 2022 to change two pumps radiator circuits.
- Was on site a few weeks before the incident as heat was not getting to the radiant floor.
- Contractor B drained the boiler and the manifold that the pumps came off. The pumps were all plugged. Contractor B cleaned out the clogged manifold. The replacement pumps were provided by the owner.
- The boiler breaker was turned off and then started again.

## Incident Summary #II-1502482-2023 (#31134) (FINAL)

### Owner statements

#### *Summary of owner statements & equipment history*

The owner had dealt with issues with the boiler system and radiant water heating system it feeds as they would come up over the years. The owner called in a contractor to deal with items such as banging noises from the boiler, water leaks, or no heat in the radiant floor heating system. This included having contractors out to site on roughly 30 occasions.

#### *Incident*

- They smelled smoke at around 4 am, went down, and found the boiler with flames shooting out two feet from the top.
- The fire department was called out.
- In the meantime, while throwing buckets of water and removing some of the ceiling tiles, they inhaled smoke and burnt their hand. The PVC pipes were melting and there was a terrible smell.

#### *Boiler history*

- The boiler had some banging noises like a “boom” sound, occasionally.
- It didn’t ignite proper. There were no smells.
- In the two to three months leading up to the incident, three pumps had to be changed in the radiant zones. This was done by a former employee of Contractor A, no longer associated with Contractor A.
- The owner in general had changed out whatever was needed if there was something broken.
- Contractor A came out to site about a year ago (likely referring to the December 2020 visit) to deal with the banging.
- Contractor A said it was for a plugged filter for the boiler, so they replaced some parts.
- The owner stated the noises were more frequent in the past and less lately.
- Since a year ago it had hardly any problems.
- The carbon monoxide alarms never went off in the house.

### Boiler manufacturer correspondence

#### *Summary of the boiler manufacturer’s correspondence*

After the boiler involved with the incident was produced in 2006, the boiler manufacturer had no records on file of interaction with the boiler. After reviewing photos of the burner, a boiler manufacturer representative indicated that the burner being fouled may have led to the holes in the burner and subsequently to the fan coupler due to flame within the premix area. The boiler manufacturer issued a bulletin in 2010 was in response to a separate incident with a failed refractory and smoke issuing from a boiler. The bulletin incorporated a retrofit kit to add a second high limit switch on top of a mounting bracket to augment the original high limit located at the bottom of the heat exchanger. The bulletin would have applied to the boiler involved with the incident.

*Note: There was no high limit switch attached on top of the mounting bracket for the boiler involved with the incident ([Photo 7](#)).*

#### *Boiler records*

- The boiler involved was produced in 2006.
- There were no commissioning, troubleshooting, or tech support records for the specific boiler involved with the incident.
- There was also no record of installation of the upgrade kit (P-252) for the boiler.
- The boiler was built with a single prong ignitor (that arcs to the burner mesh).

## Incident Summary #II-1502482-2023 (#31134) (FINAL)

### *Boiler failure*

- The burner looks to be very fouled with a considerable amount of sulfur which would corrode the burner surface causing a perforation. Once a perforation forms then a potential flash back may occur. Once it occurs, anything on top of the burner area will get extremely hot as the flame will be in the premix area which then can damage the aluminum fan coupler.
- In the boilers utilizing premix burners, the burners will degrade if there are corrosive gases in the gas supply (sulfur in natural gas, etc.) and it is not maintained at the recommended intervals. This degradation can happen over time as the burner gets dirty.
- From the Photos, the burner looks to be fouled which would corrode the burner surface causing a perforation.
- Typically, the burner will degrade first and there will always be some indication of the burner degradation like poor ignition events (detonations) or sporadic flame proving events, prior to the flame breaching the fan coupler.
- A burner in poor condition will often cause the boiler to have sporadic flame proving issues. The boiler will go into “ignition trial exceeded” events and replacing the igniter will often not solve the occurrence of these events.
- It appears that no maintenance has been performed on what looks to be the original burner.
- The boiler manufacturer stated in correspondence that the issue with this boiler did not appear to be related to delayed ignition.

### *Boiler service bulletin/ recall*

- There was a smoke incident at another site with a boiler with a failed refractory that was reported to IBC which prompted the 2010 service bulletin to add the second high limit switch.
- There is a high limit switch located at the bottom of the heat exchanger. This existing high limit switch was augmented with a secondary switch in series as part of the safety interlock chain in 2010 and located on the top mounting bracket to detect any extra heat event in the upper portion of the boiler cabinet.
- There was a retro fit kit to add the second sensor in 2010 for all pre-2010 built products. This was shared through the IBC sales, representative, and wholesale channels. The retro kit was made available to all wholesalers free of charge with some financial incentives to the installers.
- The unit under investigation would have been eligible for the free upgrade.
- No maintenance is needed (on the fan coupler) if the burner is cleaned regularly. The coupler is expected to last longer than the lifespan of the heat exchanger

### Causes and contributing factors

In review, the burner had been in use for over ten years without cleaning or service and a hole was burnt through where deposits had likely accumulated. With the hole in the burner mesh, flames were able to enter the premix area in the fan coupler. With combustion occurring within the fan coupler, it had a hole blown through it.

The incident was very likely caused by the burner not being serviced for over ten years.





Photo 1 – Boiler with fire damage at top left corner.



Photo 2 – Fan coupler with hole blown out of the top.





Photo 3a – Boiler burner mesh with hole.

Photo 3b – Clogged burner mesh indicated by light not passing through.



Photo 4 – Boiler nameplate and closeup of fire damage.





Photo 5 – Venting system fire damage.



Photo 6 – Close up of a high limit kit installed. Photo from the boiler manufacturer bulletin.

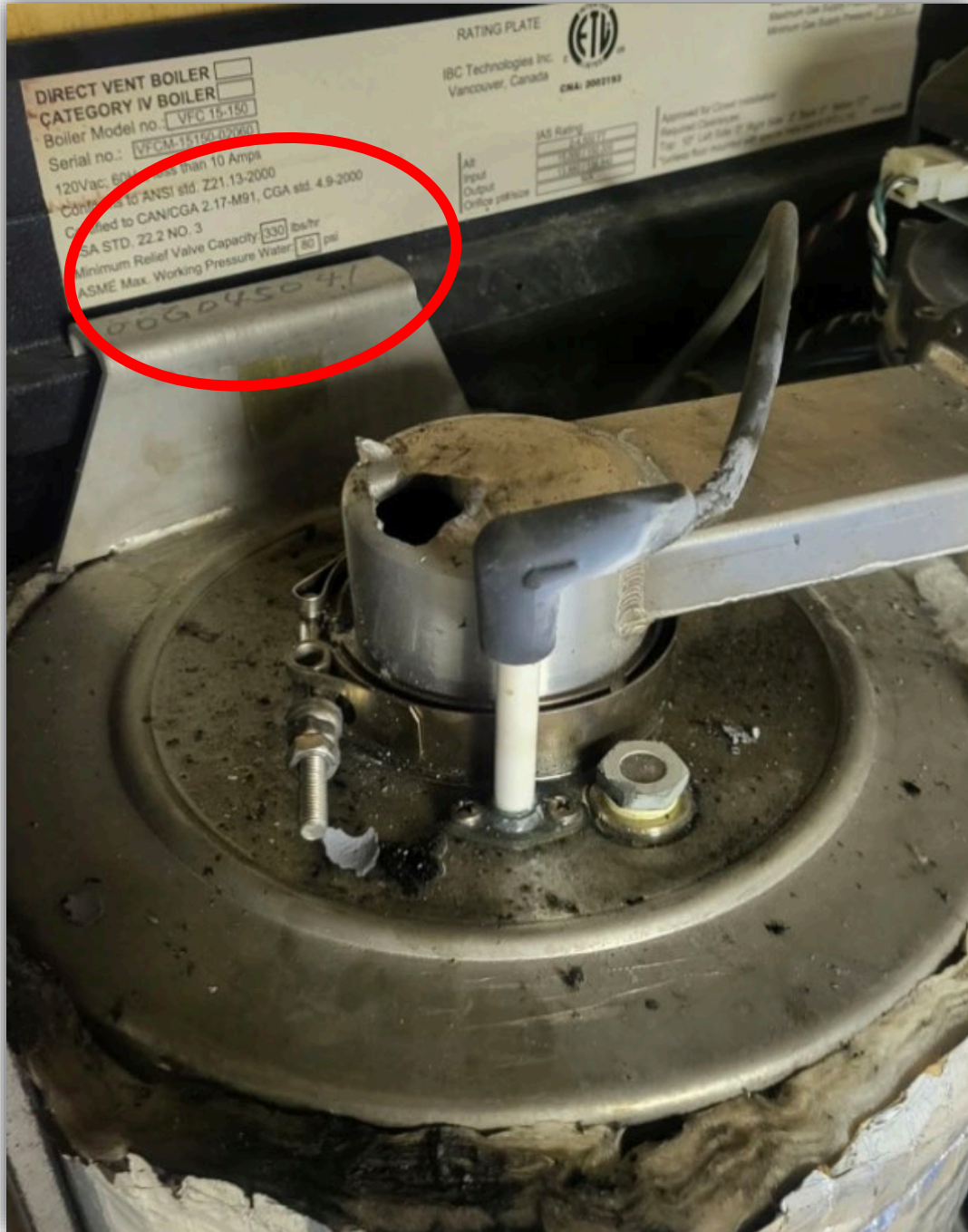


Photo 7 – No top high limit retrofit installed on boiler involved with incident.