

Incident Summary #II-1616967-2023 (#40199) (FINAL)

SUPPORTING INFORMATION	Incident Date	October 16, 2023	
	Location	Prince George, BC	
	Regulated industry sector	Gas - Natural gas system	
	Impact	Qty injuries	0
		Injury description	N/A
	Damage	Injury rating	None
		Damage description	Boiler damage included a broken sight glass, bent heat exchanger lid, burnt igniter and flame rod wiring, burnt/melted plastic intake piping connected to the venturi/gas valve, and burnt/melted appliance insulation lining.
		Damage rating	Moderate
	Incident rating	Moderate	
Incident overview	A small fire started inside a wall-hung residential heating boiler after an apparent explosion inside of the boiler's heat exchanger. This led to a blown-out burner sight glass, a bent heat exchanger lid, melted igniter wiring, and burnt insulation.		
INVESTIGATION CONCLUSIONS	Site, system and components	<p>Site and System</p> <p>Residential mechanical room comprised of concrete walls and sound barrier insulation, containing one wall-hung gas-fired residential boiler used to heat the in-floor piping system and domestic hot water.</p> <p>Components</p> <p>Boiler Heat Exchanger (Image 2):</p> <ul style="list-style-type: none"> • A hydronic boiler is a pressure vessel that generates hot water by absorbing heat through a heat exchanger. • A residential boiler heat exchanger is comprised of two sections. The first section can be thought of as a length of coiled pipe, and heating system water is pumped through this coiled pipe utilizing supply and return connections. The second section contains the burner, and this is where hot flue gasses from the burner pass over the surface of the coiled pipe, heating the water that passes through the coils. • The connections for the second section are referred to as the air intake and the exhaust. The air intake is located at the top of the heat exchanger and incorporates a combustion fan and gas valve. • The combustion fan and gas valve work together to draw in the correct amount of air and gas, which are premixed before entering the burner for ignition. Here the air/gas mixture is combusted, and hot flue gasses exit the boiler through the exhaust after passing over the heating coils. • Also inside the heat exchanger is the igniter which safely ignites the adjacent burner. It also measures the strength of the flame current throughout the heating cycle and will cause the boiler to shut down if the flame is lost or not strong enough. 	

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	<p>Boiler Venting System (Intake)</p> <ul style="list-style-type: none"> The venting air intake is a direct-vent type and supplies fresh air to the boiler from outside the building. <p>Boiler Venting System (Exhaust)</p> <ul style="list-style-type: none"> The boiler uses a fully enclosed chlorinated polyvinyl chloride (CPVC), Category 4 venting system to exhaust the products of combustion to the exterior of the residence with the assistance of the boiler fan.
<p>Failure scenario(s)</p>	<p>The boiler, installed at this residence in 2017, operated as the primary heating source in addition to heating domestic hot water via an indirect hot water tank. None of the required service or maintenance had been performed on the boiler since its installation.</p> <p>An ignition fault caused a delayed ignition explosion in the combustion chamber causing damage to the sight glass and heat exchanger lid. With the sight glass broken and the heat exchanger lid bent, the burner flame was able to escape the heat exchanger. Due to the compact design of the boiler the ignition cable and ground wires were melted along with the cabinet insulation (Image 4 & Image 5). With those wires melted and preventing the igniter from measuring flame strength, the boiler most likely developed a flame loss fault and shut down.</p> <p>The homeowner realized that the hot water was not working and hired a licensed contractor to fix the problem. When the contractor arrived, they discovered that a small fire had developed inside the boiler and components of the boiler had been damaged.</p>
<p>Facts and evidence</p>	<p>The sight glass located in the lid of the heat exchanger was broken, and the lid itself was also damaged (Image 3).</p> <p>The boiler manufacturer's installation manual states:</p> <ul style="list-style-type: none"> "Inspection of the boiler to be performed annually by a qualified service technician. 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 CO₂ (carbon dioxide) analyzer to determine proper combustion." <p>The troubleshooting section of the manual states under ignition problems:</p> <ul style="list-style-type: none"> If the boiler rumbles while igniting perform combustion analysis and check gas input and output pressures to rectify the issue. If ignition is noisy, ensure the ignitor probe is dry by running a purge clean it or replace to rectify the issue.
<p>Causes and contributing factors</p>	<p>It is likely that the lack of annual maintenance performed on the burner side of heat exchanger contributed to the delayed ignition and subsequent explosion inside of the heat exchanger and associated boiler damage.</p>



Image 1 – Boiler with the front cover removed.



Image 2 - The inside of the heat exchanger.



Image 3 - Broken sight glass located in the lid of the heat exchanger and damaged lid.

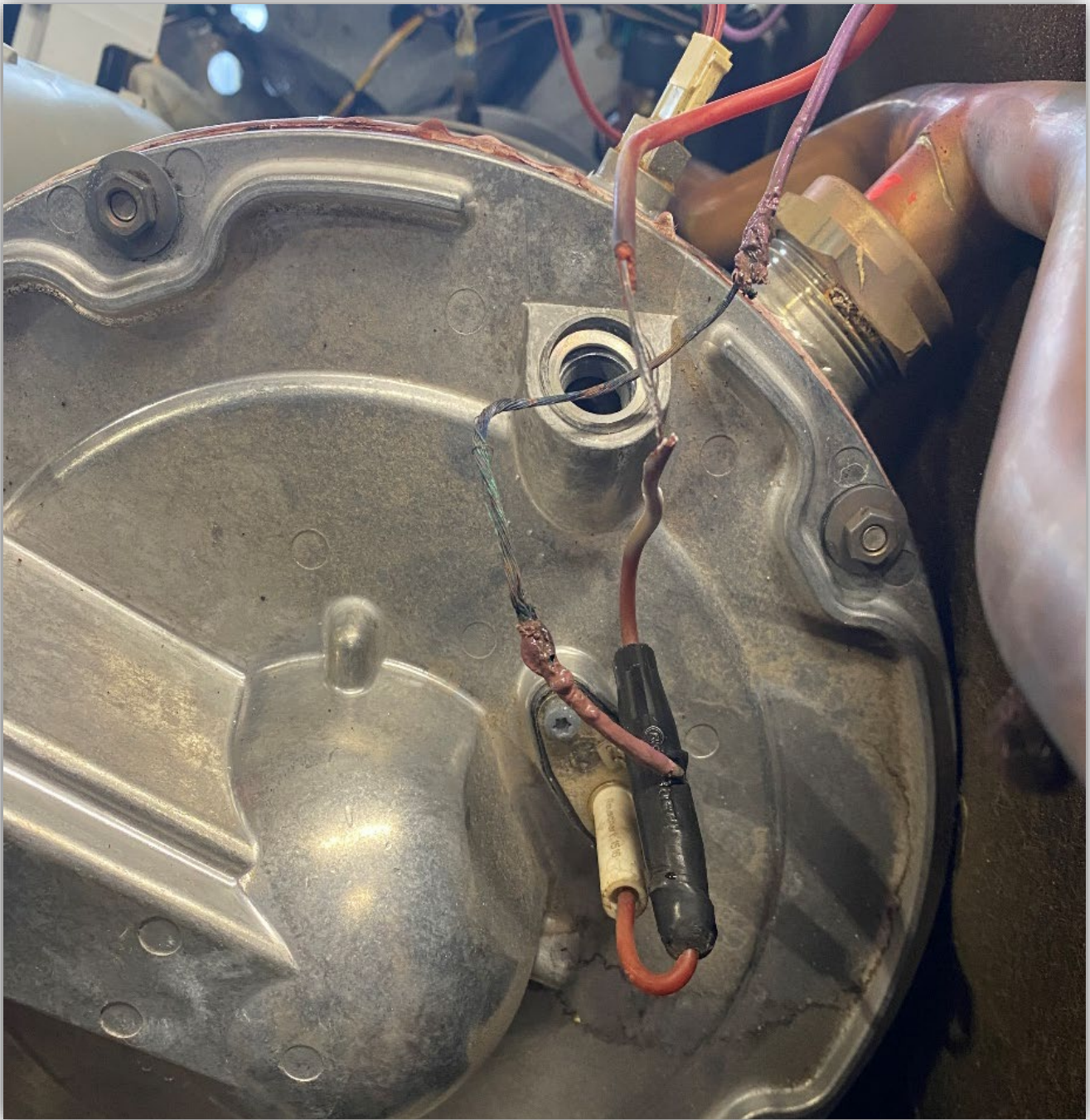


Image 4 - Melted ground wires.



Image 5 – Damaged cabinet insulation.