Incident Summary #II-1556102-2023 (#35674) (FINAL)

SUPPORTING INFORMATION	Incident Date		May 29, 2023
	Location		Interior Region
	Regulated industry sector		Gas - Propane system
	Impact – Injury	Qty injuries	1
		Injury description	Second degree burns to the face, hands, arms, and torso.
		Injury rating	Major
	Impact – Damage	Damage description	A propane explosion inside a cabin caused windows, doors, and walls to blow out as well as burns to electrical components in the crawl space and interior surfaces in the cabin.
		Damage rating	Major
	Incident rating		Major
	Incident overview		A propane fueled on-demand water heater and the supply gas line were installed in the crawl space of a cabin by a person without qualifications. After bleeding gas into the crawl space, the appliance was started, and an explosion occurred (Photo 1).
INVESTIGATION CONCLUSIONS	Site, system and components		The site consists of two adjacent properties including the main lot with a house and the secondary lot with a cabin and small carriage house. The cabin on the secondary lot had a propane gas fired on-demand water heater (Photo 7) supplied from a 118 US water gallon (USWG) propane storage tank on the main lot. A primary regulator at the tank supplies 10 pounds per square inch (PSI) to an underground gas line. The underground line runs to the secondary lot to feed a second stage regulator that further reduces the gas pressure to a lower pressure for appliances. A copper line fed a ball valve, flex hose, and the water heater in the cabin crawl space. The copper gas line that ran to the water heater had a ball-type shutoff valve upstream of the appliance in the crawl space. Flared fittings are approved for copper gas lines. They rely on the flaring out of the end of the copper pipe with a flaring tool. A nut tightens the flare copper pipe end to the flared threaded fitting. The adopted gas code for BC (CSA B149.1 Natural gas and propane installation code) requires: • The use of flare joints in copper piping, or approved fittings other than a metallic ball sleeve compression-type fitting. • The installer of gas piping to perform pressure tests prior to and after connecting an appliance, as well as liquid solution or leak detection tests after the appliance is connected. • Gas line purging to be done outdoors. The *Gas Safety Regulation* (GSR) identifies that a person must not perform regulated work in respect to a gas system unless authorized or permitted to do so. Regulated work includes the installation, operation, or testing of gas systems and equipment. The GSR also identifies that a gas appliance must display a mark or label indicating it is certified or approved in order to be installed or operated in BC. Combustible gases have a range of fuel to air ratios for enclosed spaces in which explosion can occur. The explosion range is commonly identified as between 2.1-9.5% of propane in a gas-air mixture. The 2.1% is the lower explosive level (LEL) and the 9.5% is the upper explosive level (UEL).

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Failure scenario(s)	As part of renovations to a cabin, an unapproved on-demand propane heater was installed by a person with no qualifications, license, or permit. Eleven days prior to the incident on the adjacent main property, the propane gas supplier replaced the existing 500-gallon tank with a new smaller 118-gallon tank. The gas line that had been installed to feed a carriage house and cabin on the secondary property was capped outside the buildings on the secondary lot and tested by the propane gas supplier with no leaks found. The propane gas supplier worker offered to light any gas appliances on the main property and the installer declined. The riser for the gas line to the cabin was turned off at the tank and the propane gas supplier crew left the site. After installing the on-demand water heater and powering it up, the installer tested operation of the heater with a small portable propane tank. The second stage regulator on the carriage house on the secondary property was installed, after which the shed and the cabin were both fed from that regulator. The installer connected the heater in the cabin to the copper gas line with a compression fitting prior to the ball valve in the crawl space. The fitting was not of the type approved for use with gas. On the day of the incident, the installer bled the gas from the 118-gallon tank through to the crawl space with the heater flex hose removed. The valve was partially opened for roughly 30 seconds. Neither the installer nor the installer's partner smelled gas. The propane gas, heavier than air settled downwards in the crawl space that had limited ventilation. The installer went outside to try bleeding the gas line from the outside of the secondary lot. The installer was not aware that gas was already in the crawl space and decided to try to light the heater. The installer had their partner turn on a tap at the sink above in the bathroom of the cabin, to initiate the ignition of the water heater. When the water heater arcing ignition turned on, the gas ignited there in an explosion. The installer was engulfed and burnt in the crawl space. The explosion came into the cabin through the open crawl space hatch but did not contact the occupant in the bathroom as it went the opposite direction. The explosion smashed doors, windows, and walls off the cabin's footings. After the explosion, the fire stopped.
Facts and evidence	**Site findings by gas safety officer** • The crawl space area was roughly 500 cubic feet, with limited ventilation. • For an explosion to occur in the crawl space, there would need to be roughly between 10.5 (LEL) and 47.5 (UEL) cubic feet of propane gas in the crawl space. • There were various regulatory, and code non-compliances related to the gas installation that while not causal to the incident, were indicative that the installer was not qualified to perform the installation safely. • The gas leak was found to be a water plumbing type rather than a gas fitting. • The appliance was not certified for use in Canada. • There was no permit in place for the gas installation. • A small portable propane tank was in the crawl space with its valve closed and hose disconnected from the system. **Site testing (by independent licensed gas contractor)** • Performed a low-pressure test and found a leak on a water fitting used on the gas line in the crawl space. • Performed a 15 pounds per square inch (PSI) air test for 15 minutes on the underground line no leaks found.

Gas installer statements

- Property owner's parent.
- Did trade school for mechanical work outside of the Canada prior to 1981.
- Does not have gas qualifications or certification in Canada.
- Installed a propane line alone for a new on-demand water heater on the acquired adjacent property.
- Ordered fittings from a local hardware store, the heater from an online retailer.
- Ordered the 3/4-inch gas line from a gas company out of province.
- Received second stage regulator from the propane gas supplier.
- Installed the 3/4-inch diameter, 106 feet long underground gas line.
- Installed the heater fittings and second stage regulator.
- Tested the heater with the power plugged in and a small 20 propane bottle and hose that was not connected when the incident occurred.
- Bled the underground gas line to get rid of air in the line. Bled the 106-foot gas line for roughly 30 seconds with the valve slightly open and the flex hose removed near the heater in the crawl space.
- After bleeding the gas line, was not able to smell gas in the crawl space.
- Shut off the valve at the heater and went outside, to bleed more there.
- Thought the gas should be at the crawl space valve and went inside to light the heater up.
- Did not realize the gas was already in the crawl space.
- Another family member was directly above the crawl space in the washroom.
- Asked the other family member if they could smell the gas, they could not smell it.
- Reconnected the gas flex hose to the heater.
- Asked the other family member to turn on the tap at the sink, so the heater would turn on.
- Was near the heater and saw the flame start at the heater and then was engulfed by flame themself.

Homeowner statements

- Owns the property where the incident occurred and the adjacent property where the propane tank is located.
- The cabin involved with the incident was originally built in the 1970's.
- They renovated the cabin where the incident occurred over the last couple of years.
- There was trenching done from one property to the other.

Propane gas supplier first year apprentice statements

- May 18th, 2023 – Replaced the previous 500-gallon tank with a new full 118-gallon tank with the help of an additional first year apprentice.
- Tied the new tank into the existing line to the main house and replaced the second stage regulator on the main house.
- Was told by the owner that as far as gas appliances, the house only had a stove.
- There was a riser that went to the second house (cabin involved with the incident). The cabin had a yellow prefabricated ¾ inch poly gas line with the end exposed near the cabin. The line was taped, so they installed a cap on the end.
- Turned the tank on, leak tested the outdoor connected gas lines with liquid solution.

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	• There were no leaks, so they shut off the riser at the 1/4 turn steel ball valve. • Offered to light any appliances inside and the installer declined. **Propane gas supplier certified gas fitter statements** • Was not on-site May 18th, 2023. • Attended the site the day after the incident. • Did not notice any issues with the installation near the new 118-gallon tank. • Noticed there was some non-compliant "hardware store special" gas installation on one of the buildings. • The non-compliant install would be outside the area of assessment for the propane gas supplier crew due to it being on a third building on the adjacent property. • The propane gas supplier would typically internally red flag the site if the non-compliances had been noticed. **Propane gas supplier safety specialist** • Attended the site the day after the incident. • Educated the gas fitter apprentice that the riser for the gas line was out of the ground too far indicating the burial was too shallow. • A learning from the incident is to get a copy of the gas permit when there are new gas installations.
Causes and contributing factors	The cause of the incident was the purging of the propane gas in the crawl space, by a person without qualifications. Contributing factors included: • Reliance on gas smell to indicate gas presence. • The use of a compression fitting on a copper gas line. • The absence of a gas detection meter.

Photo 1 – Exterior wall of cabin blown out.

Photo 2 - Exterior doors blown out.

Photo 3 – Damage to wall.

Photo 4 – Interior door blown out.

Photo 5 – Burn damage to crawl space entrance.

Photo 6 - 118-gallon propane tank.

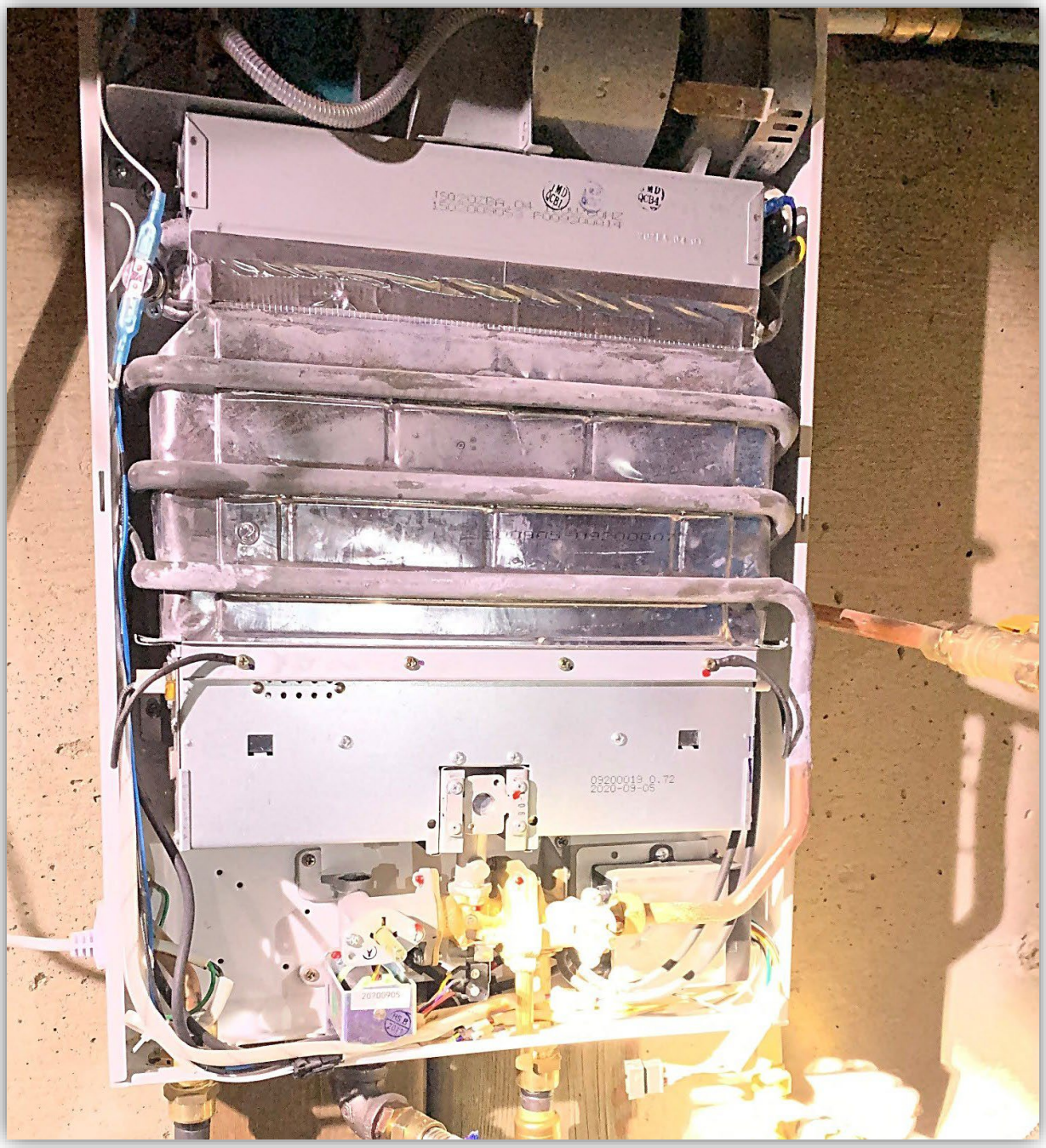

Photo 7 – On-demand water heater.

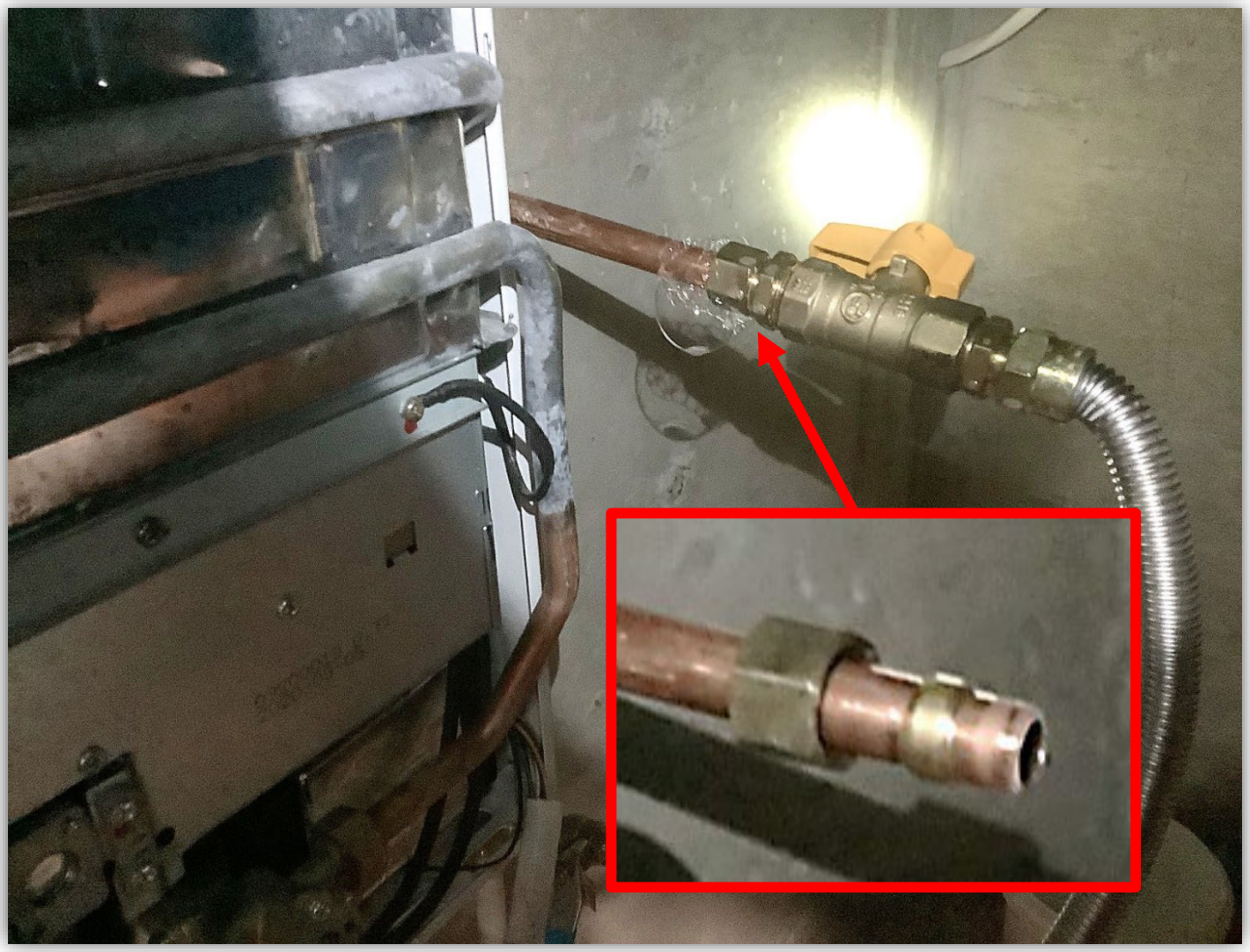

Photo 8 – Copper compression fitting (not approved for gas) leaking during post incident test.

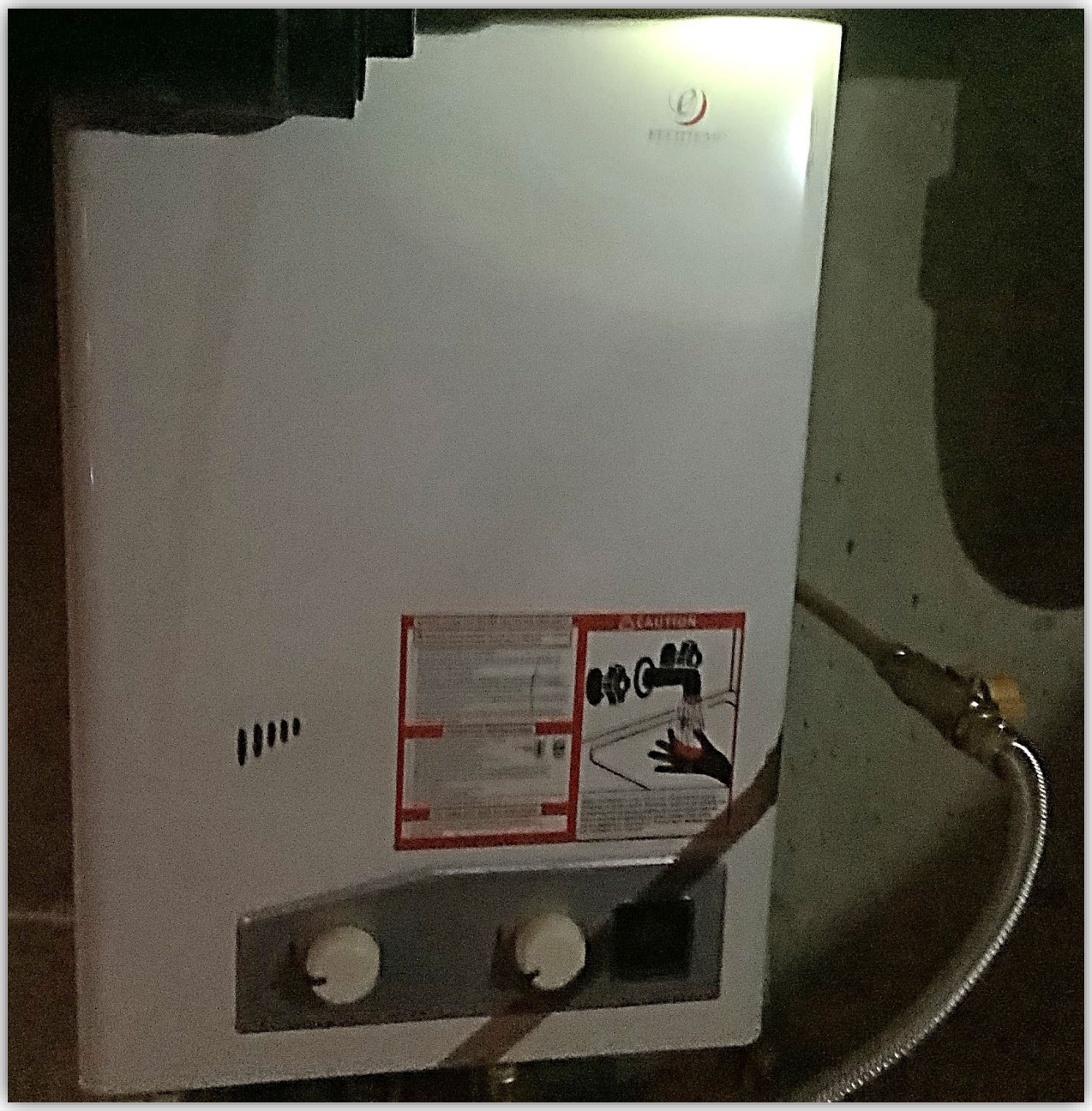

Photo 9 – Water heater with cover on.