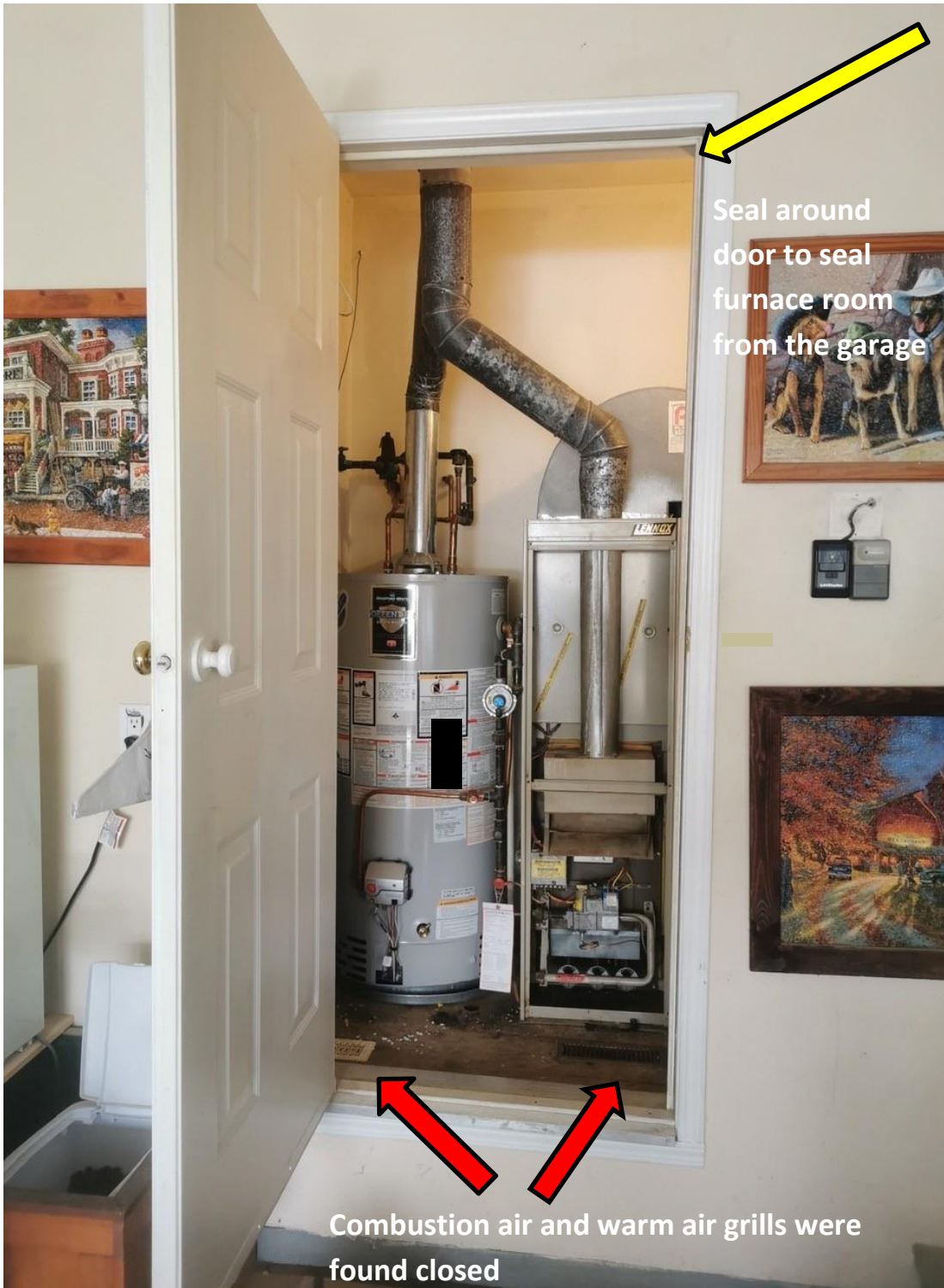


## Incident Summary #II-1008594-2020 (#17049) (FINAL)

SUPPORTING INFORMATION	Incident Date	April 29, 2020	
	Location	Chilliwack , B.C	
	Regulated industry sector	Gas - Natural gas system	
	Impact	Qty injuries	1
		Injury description	A person woke up feeling dizzy and light headed and called 911 believing he might be having a heart attack or other health emergency.
		Injury rating	Moderate
	Damage	Damage description	Crack in a residential furnace heat exchanger and high level of exposure to a toxic gas, Carbon Monoxide.
		Damage rating	Major
	Incident rating	Major	
	Incident overview	A furnace began producing high levels of carbon monoxide (CO) which resulted in the carbon monoxide entering into a single family residential home. There was only one person living in the home.	
INVESTIGATION CONCLUSIONS	Site, system and components	<p>A forced air furnace heats the home through a heating cycle where natural gas is mixed with air and ignited. This heats up the metal heat exchanger where the heat is then transferred to the incoming air.</p> <p>The furnace's blower forces this heated air through the ductwork and distributes it to the rooms through the heat registers. As the warm air fills the rooms, the cooler denser air is drawn back into the furnace via the return ducts, repeating the process.</p> <p>Natural gas requires 10 cubic feet of air for every 1 cubic foot of gas to achieve complete combustion. CO is a product of incomplete combustion, however even under normal circumstances it can be present in low levels within the flue gases. These flue gases are normally vented safely to the outdoors through venting systems.</p> <p>When gas appliances are installed in a room that is accessible through a parking garage, a positive seal needs to be present around the door. This prevents air from being taken from the garage which could include vehicle exhaust etc.</p> <p><i>** Reference tables below for properties of CO and health effects at different concentrations. Taken from Technical Safety BC's <a href="#">Carbon Monoxide Handbook</a></i></p>	

Failure scenario(s)	<p>The furnace room did not have the required combustion air supply during the time leading up to the incident. This lack of air caused the furnace to run in a fuel rich condition producing high levels of CO. Some of this CO leaked through a crack in the heat exchanger and began accumulating in the home during the 2 hours while it was warming up the house.</p>
Facts and evidence	<p>- The occupant of the home stated that he had come home from work at 6:30 PM and found the house chilly. The furnace had been off for several weeks so he turned it on and let it warm up the house for two hours. At 8:30 PM, he turned the furnace off and went to bed. He awoke at 10:30PM feeling dizzy, light-headed and confused. The occupant checked his blood pressure and found it to be abnormally high. Fearing a serious medical condition, he called 911.</p> <p>He stated that during a recent new siding installation, he noticed a duct that “went nowhere” and had the installers cover it up. He also said that when he was down in the crawlspace, he noticed 2 ducts that were not connected to anything.</p> <p>There were no CO detectors installed in the home, so no early warning alarm occurred.</p> <hr/> <p>First responders reported a CO reading of 400 parts per million (PPM) inside the home when they arrived. They reported that the occupant had been taken to hospital and placed on oxygen to be treated for CO exposure before returning home the following day.</p> <hr/> <p>A Utility technician responded to site the day after the incident to locate the source of CO. This technician tested the gas appliances in the home and found the water heater and fireplace to be in good condition and operating safely. The furnace however was noted as being in poor condition.</p> <p>This Utility Technician made note of the following points:</p> <ul style="list-style-type: none"><li>• Furnace and water heater located in a sealed room off of the garage with no indications of adequate combustion air to the space. <b>(See picture 1)</b></li><li>• Warm air ventilation grill was closed off completely.</li><li>• Flue gas readings of &gt;500PPM CO were measured inside the furnace.</li><li>• Ambient air readings of 21 PPM CO were measured with the furnace room door closed.</li></ul> <hr/> <p>A heating technician was hired to check over and repair or replace the appliances after this incident reported the following:</p> <ul style="list-style-type: none"><li>• The fireplace and water heater were in good working order.</li><li>• The furnace had dirty burners and burner compartment.</li><li>• The combustion air supply and ventilation grills for the furnace room were closed off <b>(See picture 1)</b></li></ul>

	<ul style="list-style-type: none"><li>• The furnace was turned on briefly for testing purposes and approx. 15 PPM CO was measured at each heat register in the home after 10 minutes of furnace run time.</li><li>• Serial number on the furnace nameplate shows a manufacturers date of 1989</li><li>• The furnace room is located adjacent to the garage and has a sealed furnace room door. <b>(See picture 1)</b></li><li>• The furnace was removed for further investigation. A crack in the metal heat exchanger was confirmed <b>(See picture 2)</b></li></ul>
Causes and contributing factors	It is very likely that the cause of the incident was the covering up of the combustion air supply duct to the furnace room by the recent siding install and the closing off of the ventilation grill restricting the air to the furnace. A contributing factor is that the furnace and components had not been regularly inspected and serviced.



Picture 1



**Picture 2** - Looking up into the heat exchanger a crack can be seen.

### *Properties of Carbon Monoxide*

<i>Colourless</i>	Cannot be seen.
<i>Tasteless</i>	Cannot be detected through the sense of taste.
<i>Odourless</i>	Cannot be detected by sense of smell, However, CO can also be accompanied by aldehydes. Aldehydes' odour can somewhat resemble vinegar, which can be detected by the sense of smell, and may also result in a metallic taste in the mouth.
<i>Non-irritating</i>	Carbon Monoxide will not cause irritation. However, aldehydes usually present with higher levels of CO will irritate the eyes, nose, and mucous membranes.
<i>Specific gravity</i>	Slightly lighter than air (Sg 0.975). It may, but not always collect near the ceiling, and mixes freely with air.
<i>Flammable (explosive) limits</i>	CO is flammable between concentrations of 12.5% to 74% when mixed with air. Its ignition temperature is 609°C (1128°F).
<i>Toxic</i>	Can cause death if enough is absorbed into the bloodstream.

## *Concentrations (\*ppm)    Observations and Health Effects*

<i>1 to 3</i>	Normal.
<i>25</i>	Occupational exposure limit averaged over 8 hour period.
<i>30 to 60</i>	Exercise tolerance reduced.
<i>100</i>	15-minute short-term exposure limit (STEL).
<i>60 to 150</i>	Frontal headache. Shortness of breath on exertion.
<i>150 to 300</i>	Throbbing headache, dizziness, nausea, and impaired manual dexterity.
<i>300 to 650</i>	Severe headache; nausea and vomiting; confusion and collapse.
<i>700 to 1000</i>	Coma and convulsions.
<i>1200</i>	Immediately dangerous to life and health (IDLH).
<i>1000 to 2000</i>	Heart and lungs depressed. Fatal if not treated.
<i>Above 2000</i>	Rapidly fatal.

\*1 ppm = 1 part of gas per million parts air by volume