Incident Summary #II-1311232-2022 (#25699) (FINAL)

SUPPORTING INFORMATION	Incident Date		January 8, 2022
	Location		Agassiz, BC
	Regulated industry sector		Gas - Natural gas system
	Impact – Injury	Qty injuries	2
		Injury description	Two people were taken to hospital to be treated for carbon monoxide exposure.
		Injury rating	Moderate
	Impact – Damage	Damage description	A combination heating and cooling unit serving a residential home developed rust holes along the seams of its heat exchanger.
		Damage rating	Major
	Incident rating		Major
	Incident overview		A husband and wife were rushed to hospital and placed on oxygen after the gas fired heating unit serving their home began exposing them to carbon monoxide.
INVESTIGATION CONCLUSIONS	Site, system and components		The home was being heated with an outdoor heating and cooling unit often called a rooftop unit. This type of appliance is commonly used in commercial buildings but are also sometimes used in residential applications. These units are natural gas fired, are considered a forced air heating system, and operate like the following: Natural gas is ignited in the burners, the flames heat up a metal heat exchanger and exhaust the flue gases to the outdoors through the vent. The heat exchanger transfers the heat to the incoming air. The blower forces the heated air into the ductwork and distributes it throughout the home. As the warm air fills each room, the cooler air is drawn back into the heating unit via the return ducts and the process is repeated (Diagram 1) The heat exchanger is the shield between the toxic flue gases that contain carbon monoxide and the air being distributed throughout the home by the blower. This heat exchanger must be leak free to prevent contamination of the air inside the home that is being breathed. Elevated levels of carbon monoxide (CO) are the result of incomplete combustion however even under normal circumstances, lower levels of CO are typically present in the flue gases and are considered acceptable.
	Failure scenario(s)		- The appliance was approximately 25 years old and original to the home that was built in 1997. - The homeowners had been living there for around 3 years and were not sure the last time the appliance had been checked over or serviced. - A neighbor was in contact with the 2 residents of this home almost daily. The neighbor reported that the occupants were seniors and had said that they had not been feeling well for several days leading up to the incident. They had been feeling fatigued and nauseous. On the morning of January 8th, the

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	couple had told their neighbor that they did not feel as though they had the strength to get up that morning and planned to remain in bed. The neighbor also stated that she had been in the home daily for short periods of time and did not notice anything unusual inside the home in terms of odors or signs that something may be wrong. Around this time, the neighbor had noticed a post on social media relating to "checking your furnace vents for blockages from drifting snow or ice build up". The local area was experiencing winter conditions with allot of snow and ice. The thought went through her mind of could her neighbors be having a CO issue inside their home. She brought a CO detector over to the neighbors and placed it in a common area of the home. The neighbor and couple were in disbelief when the detector soon registered an alarm indicating CO in the home. They quickly contacted the fire department who responded and took readings inside the home. They reported a CO level of 185 Parts per million (PPM). The home was ventilated, and the couple were taken to hospital to be treated.
Facts and evidence	At around 11:30 am that morning, there was a power outage in the neighborhood that lasted most of the day. Power was restored at approximately 8:00PM. The couple were taken to hospital at around 5:00 PM. This means that the gas fired heating unit was off for most of the day as it requires electricity to run. Based on this timeline, the CO levels could have been even higher than the reported 185 PPM around 5:00 PM as the heat was off and the home may have ventilated during the day. A gas utility technician was also notified and responded to the home. He found 2 other gas appliances in the home, a direct vented fireplace as well as hot water tank. He checked over and tested these appliances and found them to be in good working order and not producing CO levels in the home. The outdoor heating unit was found to be the source of the carbon monoxide. After the incident, a gas contractor was brought in to check over the heating unit and found there to be many rusted sections on the heat exchanger where the flue gases would have been leaking and mixing in with the air stream to the home. The heat exchanger was made of galvanized metal which has an anti corrosion treatment but can still be subject to corrosion/rust when in corrosive environments or when subject to long periods of time as in many years.
Causes and contributing factors	It is probable that over the years and under normal circumstances, the heat exchanger slowly began to rust. As time went on the heat exchanger became especially rusted along the seams of the tubes where connections were made during manufacturing. The seams tend to be weaker spots and are always a focus when inspecting these heat exchangers. It is likely that the heat exchanger had been rusted and leaking for some time. A contributing factor to the high levels of CO in the home is the cold weather the local area had been experiencing the days and weeks leading up to this incident. An extra demand would have been placed on the heating unit with longer and more frequent heat cycles as it maintained the warm temperature in the home.

Image 1- Front of the home during the cold weather

Image 2 - Outdoor heating unit pictured above. Supply and return duct connections cannot be seen in the picture but are located below the unit and ducted down through the concrete pad and into the crawlspace where they are connected to rooms in the home.

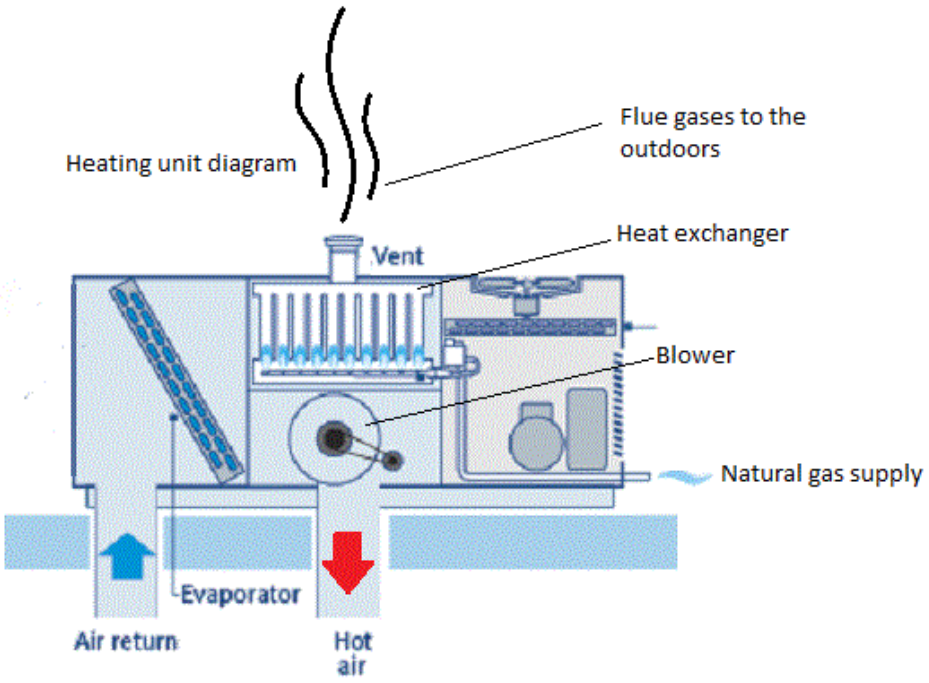

Diagram 1 – Typical rooftop heater. (Benefits of a natural gas roof unit 2021 Energir.com https://www.energir.com/en/business/equipment/all/roof-unit/)

Properties of Carbon Monoxide

Colourless	Cannot be seen.
Tasteless	Cannot be detected through the sense of taste.
Odourless	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.
Non-irritating	Carbon Monoxide will not cause irritation. However, aldehydes usually present with higher levels of CO will irritate the eyes, nose, and mucous membranes.
Specific gravity	Slightly lighter than air (Sg 0.975). It may, but not always collect near the ceiling, and mixes freely with air.
Flammable (explosive) limits	CO is flammable between concentrations of 12.5% to 74% when mixed with air. Its ignition temperature is 609ºC (1128ºF).
Toxic	Can cause death if enough is absorbed into the bloodstream.

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

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

Chart above shows the concentrations and health effects of the occupants inside this home (185 PPM)