

Incident Summary II-948424-2019 (Reference # 16043) FINAL

SUPPORTING INFORMATION	Incident Date	November 30, 2019	
	Location	Regional District Fraser Fort George BC	
	Regulated industry sector	Gas	
	Impact	Qty injuries	4
		Injury description	Carbon monoxide poisoning
		Injury rating	Major
	Damage	Damage description	None
		Damage rating	None
	Incident rating	Major	
	Incident overview	Four people were taken to hospital with carbon monoxide poisoning, likely due to a gas furnace issue in their home. Volunteer Fire Department and gas utility company were dispatched to site.	
INVESTIGATION CONCLUSIONS	Site, system and components	<p>A newly renovated residential single family dwelling (one storey with basement), contained a mixture of natural gas and wood burning appliances. Exhaust equipment was also installed in the home to exhaust air that contains moisture and contains odors.</p> <p>A natural draft central gas furnace with standing pilot and an attached decommissioned drum style humidifier located in the basement, provides primary heat to dwelling by distributing heated air through a ductwork system throughout the home. The furnace is operated by a programmable thermostat.</p> <p>A wood burning insert fireplace located in the basement provides secondary heat for the home.</p> <p>A direct vent gas fireplace installed as an insert into a masonry chimney located upstairs provides secondary heat for home.</p> <p>A direct vent gas on-demand water heater located downstairs provides domestic hot water throughout the home.</p> <p>A gas range installed in the kitchen for cooking.</p> <p>A future gas BBQ outlet located outdoors on back deck.</p> <p>Direct-vent appliance — an appliance constructed so that all the combustion air is supplied directly from, and the products of combustion are vented directly to, the outdoors by independent enclosed passageways connected directly to the appliance.</p> <p>Natural-draft burner — a burner that is not equipped with a mechanical device for supplying combustion air.</p> <p>All gas and wood burning appliances require a combustion air supply to operate correctly. The attached diagram (Example 1) indicates a typical combustion air supply to a natural draft furnace.</p>	

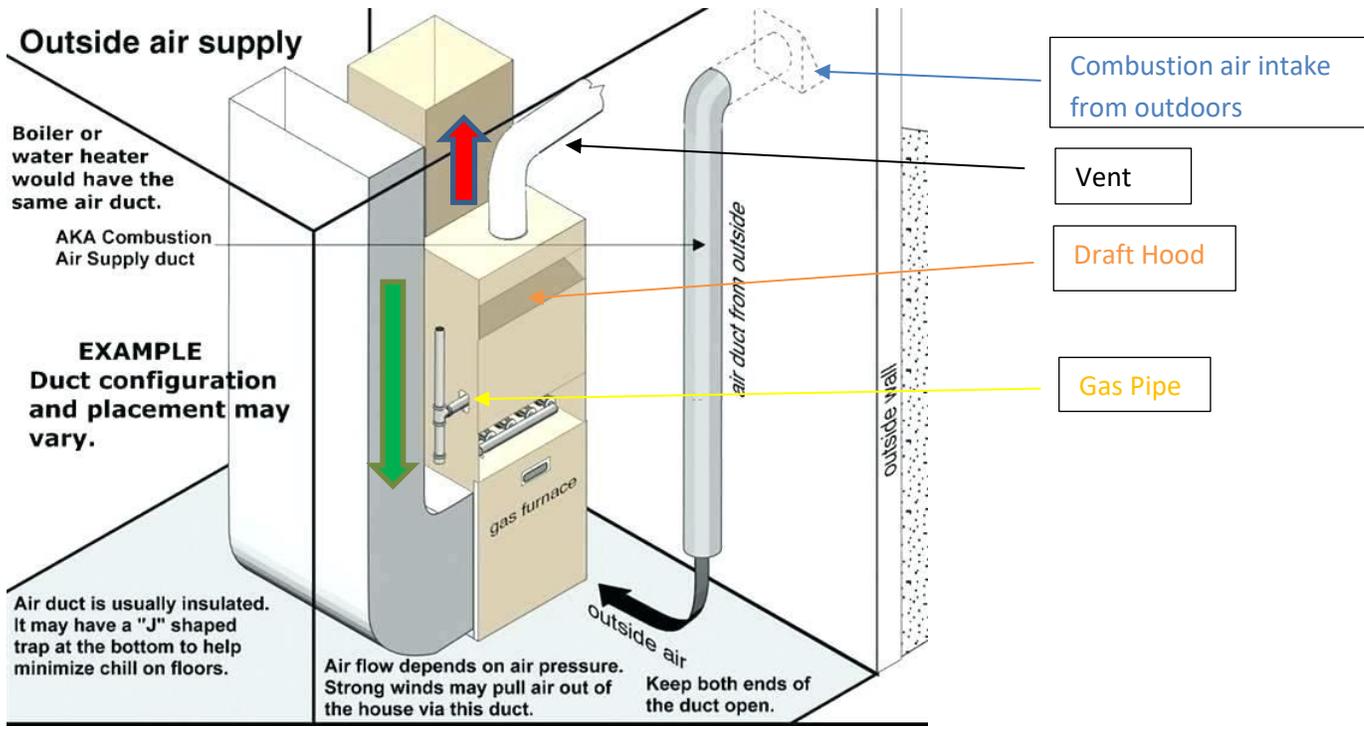
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	<p>Combustion air — the air required for satisfactory combustion of gas, including excess air.</p> <p>The natural draft gas furnace, range and wood burning fireplace insert require combustion air to operate correctly.</p> <p>Two bathroom fans exhaust air to outdoors one located upstairs one located in the basement. An over the range hood fan exhausts air to the outdoors and an electric dryer located in the basement exhausts air to the outdoors.</p> <p>A four inch fresh air pipe from outside was connected to the furnace return air ducting (building air), which is meant to replace air being removed from the house by exhaust fans, wood fireplace and the clothes drier. (Example 2 & Picture 3)</p>
<p>Failure scenario(s)</p>	<p>Likely due to the depressurization of the newly renovated home the natural draft furnace and wood burning insert fireplace were unable to vent correctly. The addition of an over the range exhaust hood, created a lack of combustion air and make-up air which was likely the cause of the appliances back drafting.</p> <p>If the over the gas range exhaust fan was turned on it would have exhausted inside air out of the home potentially creating a depressurization state. The home would have used open sources of outdoor air to replace the air being exhausted. The only outdoor air sources were a 4" building air duct connected to the return air of the natural draft gas furnace, the furnace venting through the draft hood and the wood fireplace insert chimney. If the over the range exhaust fan was turned on prior to the spillage susceptible appliances being fired a back drafting condition could have been present. It is probable that the automatic thermostat change from 16 to 23 degrees Celsius causing the furnace to operate for extended period, and the exhaust hood causing a negative pressure in the home the products of combustion from the furnace spilled into the mechanical room instead of safely up the chimney.</p> <p>As the furnace blower started it began drawing products of combustion into the return air ducting through the disconnected humidifier and furnace air filter openings. Which efficiently distributed a high concentration of carbon monoxide throughout dwelling via the supply air ducting. (Picture 4)</p>
<p>Facts and evidence</p>	<p>Licensed gas contractor performed a depressurization test on the house witnessed by gas safety officers.</p> <p>Appliances which are not direct-vent can be affected by building depressurization, especially at the start of a call-for-heat cycle. If adequate make-up air is not supplied, mechanical exhaust equipment (bathroom fans, kitchen fans, dryers, ventilators) may cause depressurization of the structure to the point where appliance vents are reversed and products of combustion spill within the structure.</p> <p>The 1000 cubic foot per minute kitchen exhaust fan was run for 15 mins, turned up the thermostat to turn on the heat and the furnace was unable to vent correctly due to the amount of air being removed from the house by the exhaust fan, the wood burning fireplace and insufficient fresh air from outside entering the house. The products of combustion spilled into the house instead of going up the chimney.</p> <p>Furnace had a partially plugged heat exchanger causing the furnace to produce excessive carbon monoxide (CO). CO readings were taken by a licensed gas fitter</p>

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	<p>at time of the incident. They stated that one of the flue passages was partially plugged.</p> <p>The homeowner stated that there were no carbon monoxide detectors in the house at the time of the incident, a missing furnace air filter access door, no dedicated combustion air for the wood fireplace, and a lack of furnace maintenance. The wood burning fireplace was in use at the time of the incident, also removing air from the house.</p> <p>Upon inspection, the four inch fresh air pipe this was found to be covered by perforated metal soffit which would have reduced the air flow through the fresh air pipe.</p> <p>Because the six inch humidifier opening to the return air was not capped, it increased the likelihood of the products of combustion (furnace) being distributing throughout the house.</p>
<p>Causes and contributing factors</p>	<p>It is likely that due to the insufficient fresh air entering the house during the operation of the kitchen exhaust fan, prolonged operation of the furnace with no CO detectors and an overall negative air pressure condition in the house combined to create this hazardous CO atmosphere.</p> <p>Due to the furnace conditions, it allowed the high concentration of carbon monoxide to be distributed throughout dwelling.</p>

Example 1: Typical Natural Draft Furnace with draft hood and outdoor air supplied.

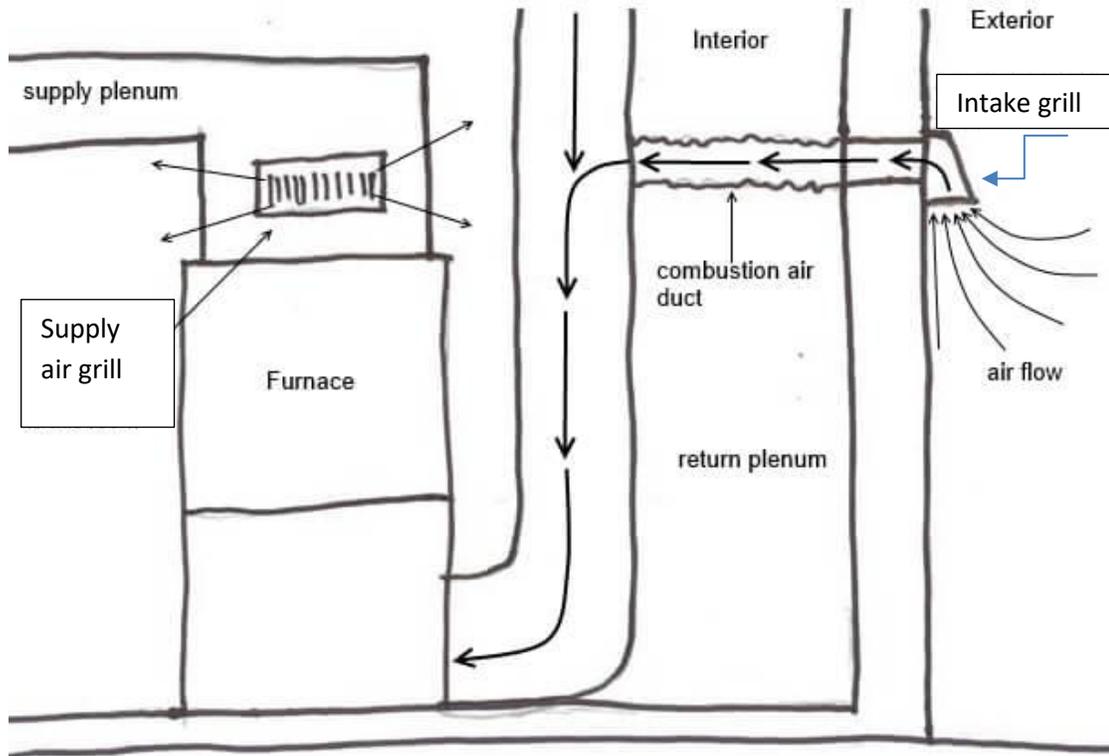


RED arrow indicates supply air to home from furnace

GREEN arrow indicates return air from home

Example 2: Typical Building Air supply for older homes

Combustion air duct connected to return plenum



Picture 3:

Soffit covering building air intake

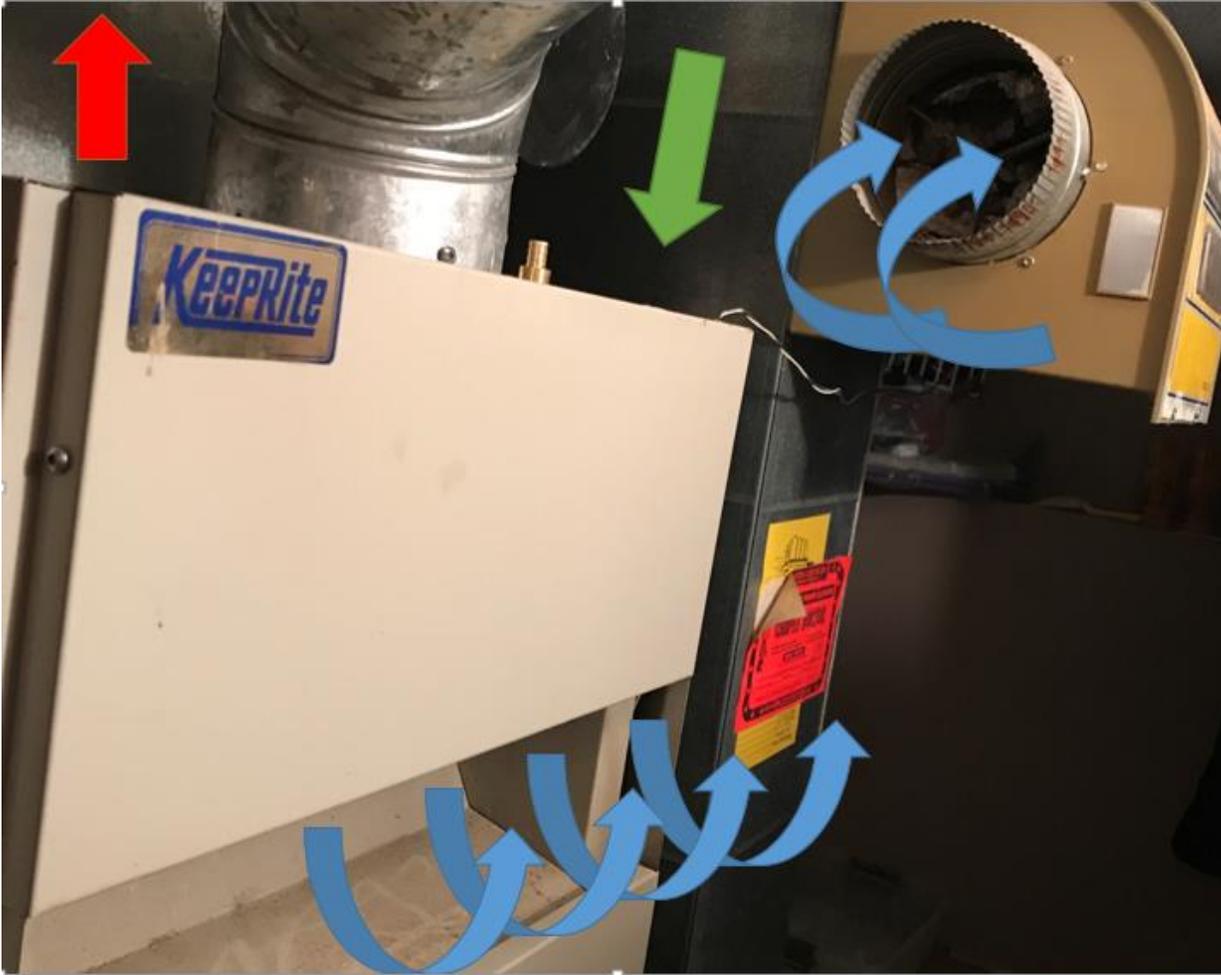


Hole cut in soffit shows building air intake.



Picture 4:

Blue Arrows show products of combustion, Green arrow direction of return air, Red arrow direction of warm air supplied to house.



Picture 5:

