Incident Summary #II-1769734-2024 (#52490) (FINAL)

SUPPORTING INFORMATION	Incident Date		October 1, 2024
	Location		Chilliwack
	Regulated industry sector		Gas - Natural gas system
	Impact – Injury	Qty injuries	1
		Injury description	Two occupants of the home experienced headaches on multiple occasions.
		Injury rating	Moderate
	Impact – Damage	Damage description	Gas appliance flue gasses containing carbon monoxide (CO) were released into the living space of the residence.
		Damage rating	Moderate
	Incident rating		Moderate
	Incident overview		A gas fired water heater had been installed for over a year in the mechanical room of a single-family home. The incorrect installation of the water heater resulted in products of combustion, including toxic CO, to spill from the venting system into the mechanical room and migrate into the living spaces of the dwelling.
INVESTIGATION CONCLUSIONS	Site, system and components		The home was originally constructed when both the furnace and water heater were category I appliances. A category I appliance operates with a neutral or negative pressure in a metal venting system that relies on the heat from combustion to create a draft in the vertical vent to draw products of combustion (flue gas) out of the appliances. This type of venting is commonly referred to as a natural draft venting system. The hot exhaust would naturally rise and pull the flue gas from the appliance, along with dilution air provided to the mechanical room from an outdoor fresh air duct, up the metal vent stack to be safely released at the vent termination outside at roof level. The replacement water heater was a category III appliance which uses a fan to push the products of combustion under a positive pressure through a sealed plastic pipe venting system to the outdoors. The plastic pipe venting system is glued together at all joints to create a sealed system where products of combustion including CO are safely released to the outdoors. The manufacturers installation manual describes that a sealed plastic venting system must be used for this appliance, and it is not acceptable to connect components of this venting system with another Category I venting system. The combustion of natural gas requires a proper air and fuel ratio for complete combustion. An improper air fuel ratio can result in incomplete combustion of the gas. One of the by-products of incomplete combustion is CO. CO is a colourless, odourless, tasteless gas that is toxic to humans and animals. Exposure to CO interferes with the body's ability to absorb oxygen, which can result in serious illness or death. Gas appliances in BC are required to be installed or replaced by qualified persons under appropriate permissions. The appliances are required to be installed in adherence to gas codes, regulations and the appliance manufacturers certified installation instructions.

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	Gas appliance installation or replacement requires an installation permit. Some appliances can also be replaced by obtaining and affixing a gas appliance replacement decal in place of a full installation permit. Technical Safety BC has an appliance replacement decal program, in which an appliance decal can be applied by a certified gas fitter working for a licenced contractor. The appliance replacing the existing appliance cannot have any alteration to the existing vent system or the gas piping system. For more information on the gas appliance replacement decal program see this link: DIRECTIVE: Replacement Appliance Permit Decals.
Failure scenario(s)	The original appliances installed in the residence, when it was constructed over 30 years ago, used a metal venting system for the natural draft furnace and water heater. The furnace was later replaced with a high efficiency model that utilized plastic venting leaving only the water heater connected to the original metal venting. When the water heater was replaced, a contractor installed a more energy efficient Category III model for use with plastic venting. The venting system was incorrectly adapted to the original metal venting system instead of being properly run safely to the exterior of the home. The connection point between the two vent systems was not sealed and was open to the mechanical room. The water heater was affixed with a gas appliance replacement decal and did not have an installation permit. An installation permit was required for the work due to a different style of water heater being installed and an altered venting system. The lack of an installation permit removed the potential for an inspection of the work by a gas safety officer which may have identified the non-compliant installation. During operation of the water heater, CO was released into the home when the 2” diameter plastic vent system section of pipe was installed approximately 3” into the inside the 4” metal venting system. There was no attempt made to seal this connection and there was no adapter to connect the two different venting systems as the existing metal venting system was not designed to operate under positive pressure. The result of this connection was that the products of combustion spilled out of the gap in the venting system inside the mechanical room (Image 2). Natural gas was supplied to the water heater with the existing copper tubing that served the previous appliance. The new water heater required more natural gas to operate the burner, but the existing supply tubing was too small of a diameter to effectively supply the required pressure and volume the water heater required. An undersized fuel connection can result in the burner not being able to operate as designed and may release greater amounts of CO. This may have also contributed to the amount of CO released into the home. The home did not have a CO detector installed to alert the occupants that there was CO present inside the dwelling. The incorrect installation and CO exposure to the occupants was only identified when a different gas contracting company was hired to replace the existing furnace. The technician identified the incorrect venting of the water heater and noticed that when the water heater operated, that flue gases began to spill out of the venting.

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Facts and evidence	Furnace contractor statements • When they were working in the mechanical room, the water heater fired and the products of combustion from the burner spilled from the venting where the plastic vent pipe enters the metal vent pipe into the room. • They smelled the leaking products of combustion from the venting system almost immediately and shut the gas off to the appliance before evacuating the mechanical room. • They shut the gas off to the water heater and opened the door to the basement to ventilate. • They discussed the issue with the occupants of the home and discovered the occupants had been experiencing headaches at night which is a symptom of CO exposure. Homeowner statements: • They had both experienced headaches since the water heater was replaced. • They did not have a CO detector in the home. Gas contracting company owner statements: • They were hired to replace the water heater and sent a subcontractor to complete the work. • They believed the subcontractor was aware of what is required under the decal program were as they operated their business for 30 years. • They left the responsibility of the installation to the subcontractor and does not inspect the installations. Gas subcontractor statements: • They were not aware of the requirements of the appliance replacement decal program. • They had been using gas appliance replacement decals for quite a while and had never been advised of what the requirements were for using the decals. • They did not know about having to obtain an installation permit for an appliance when a venting system is altered or installed. Site observations: • The manufacturers installation instructions clearly describe the venting system required to install the water heater. • The venting system was not constructed as required by the appliance manufacturer or compliant with the Natural Gas and Propane Installation code.

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Causes and contributing factors	It is likely that the cause of the incident was the water heater venting system not being installed correctly which allowed CO to leak into the home from the vent opening when the water heater was operating. Contributing factors to the incident include: • The contractor not installing the replacement water heater in adherence to code and the manufacturers certified installation instructions. • A gas appliance replacement decal being incorrectly used in place of a required installation permit prevented the possibility of the installation being inspected by a gas safety officer and early identification of the incorrect installation. • The home not having a CO detector which could have alerted the occupants to the presence of carbon monoxide inside.

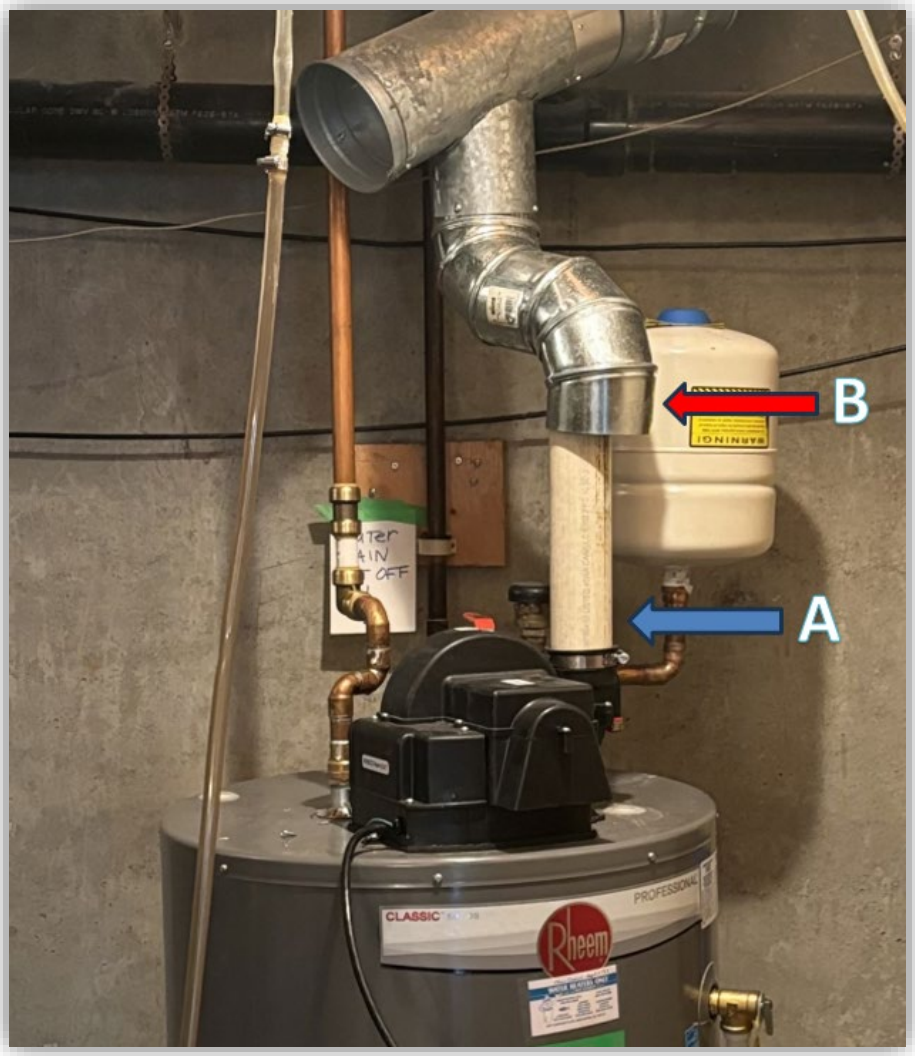

Image 1 - The replacement water heater installed one year prior to the reported incident date. The plastic venting system connected to the blower assembly [A] is inserted into the existing metal venting system [B].

Image 2 - The end of the 2” plastic pipe is visible inside the 4” metal vent. There is no adapter made for this installation, and the installer did not attempt to seal the gap between the two venting systems. This allowed carbon monoxide from the water heater to spill into the residence instead of being directed to the outside.