

# Carbon Monoxide Incidents (2007 - 2015)

Carbon monoxide (CO) is a poisonous gas that is colourless, odourless and tasteless. If inhaled in sufficient quantities, CO can interfere with the body's ability to absorb oxygen. At low concentrations, symptoms of CO poisoning present similar to flu symptoms: headaches, nausea, fatigue and dizziness. In higher concentrations or prolonged exposure, symptoms can worsen and cause loss of consciousness and death.

Carbon monoxide exists naturally in the atmosphere in small concentrations and is also a combustion by-product of carbon-based fuels. CO is produced when the combustion of a carbon-based fuel is incomplete, usually due to insufficient oxygen during the combustion process. Balanced fuel and air mixtures can minimize the amount of CO produced during combustion, while venting combustion gasses to the atmosphere prevents CO build-up from occurring in enclosed spaces.

Figure 1:  
Basic Combustion Diagram

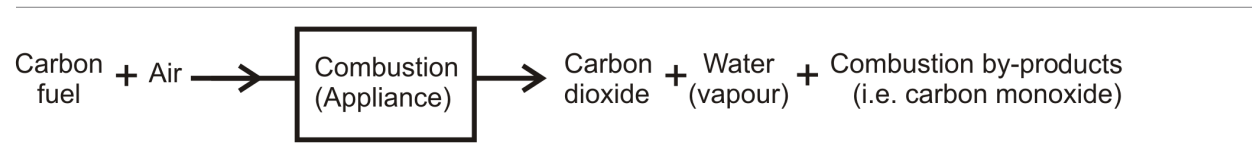
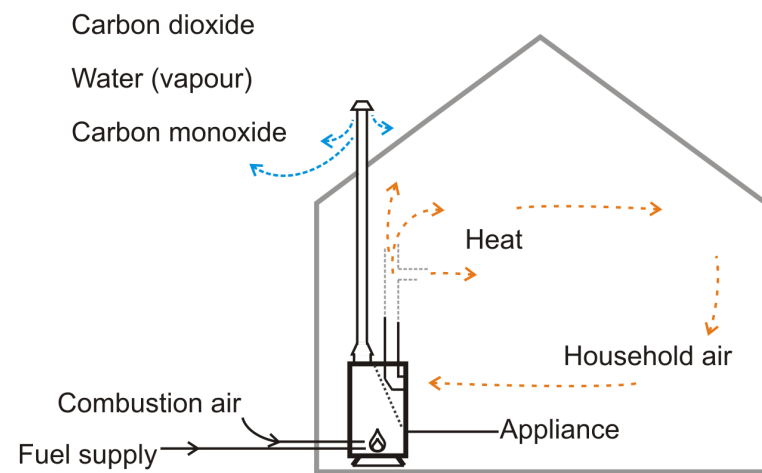


Figure 2:  
Basic Illustration of a Residential Appliance



BC Safety Authority (BCSA) observed incidents involving regulated equipment that resulted in CO poisoning causing fatalities and other injuries. CO poisoning incidents are usually a result of at least one of the following two conditions being present:

1. A failure to effectively vent the products of combustion away from enclosed, occupied spaces.
2. Excess CO being produced by fuel-burning appliances.

This case study provides an overview of the incidents involving CO that were reported to and investigated by safety officers occurring from January 1, 2007 to December 31, 2015. It is important to note that BCSA does not regulate all fuels that produce CO; therefore, occurrences involving fuels not regulated by BCSA are not considered in this review.

## BCSA Investigations

A total of 84 carbon monoxide incidents were reported and investigated between 2007 and 2015. These incidents resulted in nine fatalities and 161 non-fatal injuries. A list of the incidents is included in Table 2, at the end of this document.

There is a variation in the number of carbon monoxide incident investigations from 2007 to 2015. Figure 4 shows the distribution of CO incident investigations by month. Most CO-related incidents occurred from October to April.

Figure 3:  
Incidents Investigated by Gas Safety Officers

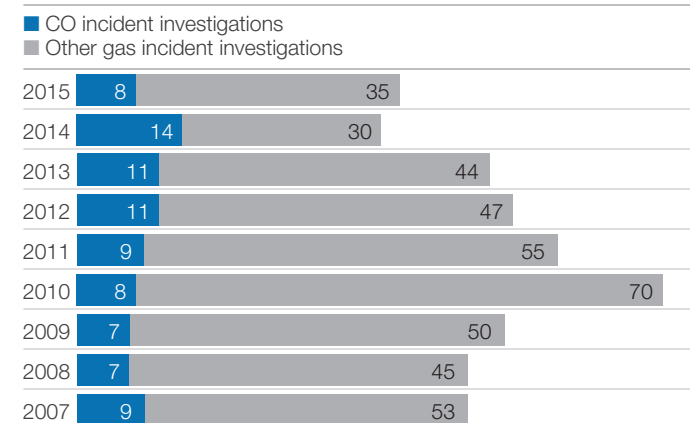


Figure 4:  
Carbon Monoxide Incidents Investigated by Month and Year

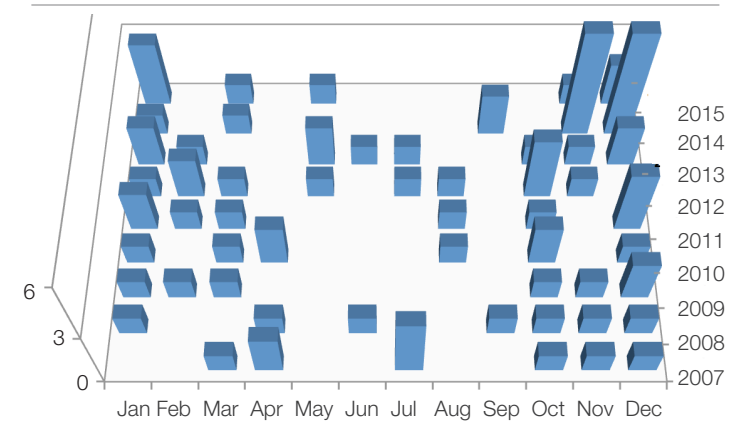
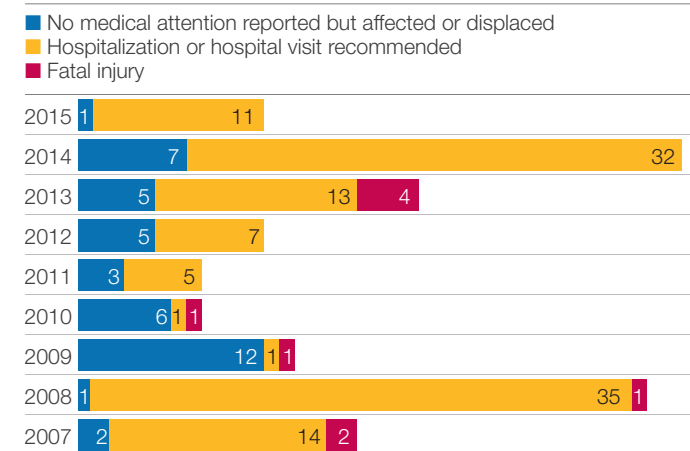


Figure 5:  
Injuries Resulting from CO Incident Investigations



Note 1. The categorization of the non-fatal injuries in Figure 5 differs from the categorization used in the remainder of the State of Safety Report. Carbon monoxide injuries are usually classified as 'moderate' or 'major injuries.'

Note 2. BCSA receives its injury reports and descriptions from operators or first responders at the time of, or immediately following, the incident. Injuries may develop after the initial reports were made to BCSA and the long-term effects of a resultant injury may not be recorded as part of BCSA's investigation.

# Carbon Monoxide Incidents (2007 - 2015)

During this nine-year period, CO incidents resulted in nine fatalities and 161 non-fatal injuries. In June 2008, one incident resulted in 27 employees at an industrial facility where the investigation stated the employees being taken to hospital and found to have CO poisoning. In 2014, one incident was reported to have affected 15 people who went to hospital after some residents reported experiencing symptoms of CO exposure.

Most incidents occurred in residences and involved residential furnaces, boilers or water heaters. Each investigation identified at least one appliance that produced, or may have produced, carbon monoxide.

Figure 6:  
**Structures Where CO Incidents Occurred**

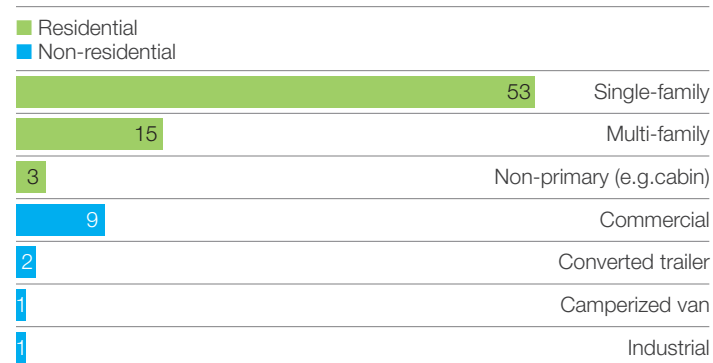
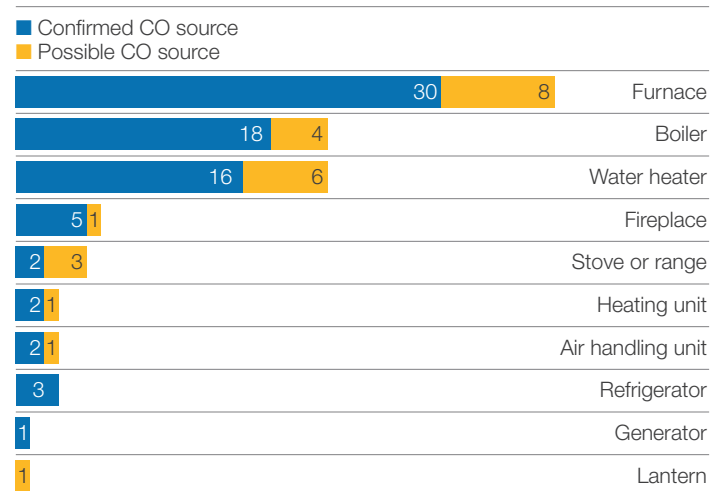


Figure 7:  
**Sources of Carbon Monoxide [Note 1]**



Note 1: Some investigations identified multiple appliances that may have produced CO, yet did not confirm which was most likely the CO source; therefore, the total number of appliances exceeds the number of events. For example, there were 38 incidents that identified furnaces for potential involvement. In 30 of these 38 cases, the investigation confirmed that the furnace was the source of excess CO. In the remaining eight cases, the investigation could not confirm that the furnace produced excess CO, or the investigation identified that there were other appliances (in addition to the furnace) that could have produced excess CO.

Investigation activities focus on understanding the relationship between regulated work or regulated equipment and the factors that may have contributed to the cause of the event. Factors contributing to the CO incident occurrences are summarized in Table 1. Additional details are available in Table 2 at the end of this document.

Table 1:  
**Summary of Factors Contributing to CO incidents**

Causes and contributing factors that attributed to the incident	Qty of Events
Ventilation and inability to vent combustion products	22
Service, maintenance and/or equipment replacement	16
Equipment or component failures	15
Installation issues	14
Investigations were inconclusive [Note 1]	6
Unqualified persons performing regulated work	5
Unsafe use of equipment	3
Poor air-gas ratio	2
Wind creating a downdraft	1

Note 1: Although elevated CO was observed, the investigation was either unable to determine the cause or unable to rule out the involvement of regulated equipment.

## Carbon Monoxide Incident and Injury Summary

From 2007 to 2015, there were 84 incidents reported to BCSA. These incidents resulted in nine fatalities and 161 non-fatal injuries. Most CO incidents occurred from October to April. Most incidents occurred in residences and involved residential furnaces, water heaters or boilers as the source of CO, while ineffective venting and maintenance were identified as the most prevalent contributing factors.

This data highlights the importance of proper installation and maintenance of residential fuel-burning appliances and their venting systems. It also illustrates the importance of using CO detectors in homes that have fuel-burning appliances.

# Carbon Monoxide Incidents (2007 - 2015)

This listing provides an overview of the incidents involving carbon monoxide (CO) that were reported and investigated by BCSA safety officers. It is important to note that BC Safety Authority does not regulate all fuels that produce CO, therefore occurrences involving fuels not regulated by BCSA are not considered in this listing. Incidents involving work or equipment regulated under the Safety Standards Act are required to be reported to the appropriate provincial safety manager.

The Province of British Columbia, however, delegated partial administration of the Safety Standards Act to a number of local governments. These local governments administer gas assessment programs for detached dwellings with gas services at a pressure of 14.0kPa gauge or less with a total connected load for the meter of 120kW or less and are identified in Appendix H. Gas incidents, including carbon monoxide incidents, occurring in these municipalities would be reported to the local government safety manager and may not be reported to BC Safety Authority.

BC Safety Authority receives its injury reports and descriptions from operators or first responders at the time of, or immediately following, the incident. Injuries may develop after the initial reports were made to BC Safety Authority and the long term effects of a resultant injury may not be recorded as part of the BCSA investigation.

**TABLE 2: CARBON MONOXIDE INCIDENT INVESTIGATIONS**

INCIDENT DATE	CITY	INJURY TYPE				INCIDENT DESCRIPTION	POSSIBLE CAUSE(S), CONTRIBUTING FACTOR(S) AND DESCRIPTIONS	CAUSE CATEGORY	OCCUPANCY/ PREMISE TYPE	EQUIPMENT			
		TOTAL INJURED/ AFFECTED	FATAL INJURY	HOSPITALIZED/ HOSPITAL VISIT RECOMMENDED	NO INJURY REPORTED BUT AFFECTED/ DISPLACED					IDENTIFIED IN INVESTIGATION	SOURCE OF CO	POSSIBLE SOURCE OF CO	GAS TYPE
17-Mar-07	Surrey	1	0	0	1	A person was exposed to CO. The person was taken to hospital but decided not to stay because there was a six hour wait; by the time the person arrived at the hospital, the person claimed he was feeling better.	Defective gas appliances and associated venting.	Equipment failure	Residential	Furnace, water heater	Furnace	Water heater	Natural gas
11-Apr-07	New Westminster	None	0	0	0	An odour was reported at a condominium building; building was evacuated.	The fan belt was found to be broken, which would have caused improper venting. Combustion products could have been drawn into the makeup air in-stream and pumped into hallways. A copper sensing tube was found lying in the bottom of the switch compartment.	Component failure	Residential	Makeup air unit	Makeup air unit	-	Natural gas
20-Apr-07	Prince George	2	0	1	1	Gas utility responded to an odour call.	Cracked heat exchanger and flame roll-out due to lack of maintenance.	Lack of maintenance	Residential	Furnace	Furnace	-	Natural gas
2-Jul-07	Vernon	2	2	0	0	Two people died from CO exposure.	The cabin was built of tight construction with little air leakage; no combustion air brought into the cabin; refrigerator was not installed to manufacturer's recommendations.	Incorrect installation	Recreational (Cabin)	Refrigerator	Refrigerator	-	Propane
6-Jul-07	New Westminster	0	0	0	0	A person contacted his gas contractor after noticing dew-like condensation on the basement walls.	About six months prior, the contractor had replaced the home's hot water heater and furnace and common-vented into a masonry chimney. The contractor was not aware of the pool boiler that was located in a different area of the basement. The chimney liner that was installed to accommodate the replaced appliances (water heater and furnace) which blocked the chimney vent for the pool boiler. The boiler then spilled at the draft hood due to a blocked vent.	Vent obstructed; Combustion products unable to vent	Residential	Pool boiler	Pool boiler	-	Natural gas
18-Jul-07	Duncan	1	0	1	0	A person was taken to hospital and treated for CO poisoning.	The heat exchanger was cracked and allowed CO to enter the circulating air stream.	Component failure	Residential	Furnace	Furnace	-	Natural gas
5-Oct-07	Coquitlam	2	0	2	0	Two people were taken to hospital with possible CO poisoning	The roof's rain cap on the B-vent was changed when the house was re-roofed earlier in the year. The rain cap was replaced with the incorrect type and partially blocked the B-vent. The furnace filter was the wrong size and the door of the blower compartment was partially open.	Equipment service/ replacement	Residential	Furnace	Furnace	-	Natural gas
27-Nov-07	Sun Peaks	6	0	6	0	Six people were taken to hospital with CO poisoning.	The boiler's vent termination pipe was dislodged and the boiler would continue to shut down where the pipe became dislodged. The boiler would then shutdown and 'recycle itself' continuously. During start-up, the boiler was producing more than 1000ppm and decrease to 47ppm at high-fire.	Combustion products unable to vent	Residential	Boiler	Boiler	-	Natural gas
14-Dec-07	Pitt Meadows	4	0	4	0	Four people were treated for CO poisoning.	The utility technician tested for CO; detected CO at the furnace.	Unable to determine cause	Residential	Furnace	-	Furnace	Natural gas
26-Jan-08	Denman Island	1	1	0	0	A deceased person was discovered in a burned out camperized van.	It is unknown if fire was started by vehicle's electrical system, smoking materials, or operation of catalytic heater within vehicle. If heater was in use, CO poisoning/ impairment was possible, or heater could have ignited combustibles inside vehicle. It is possible the deceased was using the heater within the van and was overcome by CO and that the heater could have produced CO by operating the appliance in an enclosed space without adequate air supply. It is also possible that the heater was placed too close to combustible material and caused ignition.	Unable to determine cause	Camperized vehicle	Catalytic heater	-	Catalytic heater	Propane
11-Apr-08	Vancouver	0	0	0	0	A gas odour was reported to the fire department.	A tarp was temporarily installed for roof repairs. All of the B-vented appliances (gas fireplaces, boilers, make-up air units, ranges) were venting to the space below the tarp. Combustion products were trapped under the tarp where it was recirculated by roof top equipment and heating appliances. The CO then migrated throughout the building by the hall pressurization equipment.	Combustion products unable to vent	Commercial	Fireplaces, boilers, make-up air units, ranges	Fireplaces, boilers, make-up air units, ranges	-	Natural gas
18-Jun-08	Armstrong	27	0	27	0	Twenty-seven people were taken to hospital for CO poisoning.	A "negative from the fan coil unit" caused the boiler not to vent. The amount of rust on the back of the boiler indicated the boiler had not been vented for an extended period of time.	Combustion products unable to vent	Industrial	Boiler	Boiler	-	Natural gas
1-Sep-08	Lumby	5	0	5	0	Five people were taken to hospital for treatment after exposure to CO.	Inspection of the premise revealed one ventless propane refrigerator and one cook-top stove. There was no combustion air into the premise; the refrigerator had not been serviced for some time. The refrigerator vent was partially plugged, the burner was not burning properly as the air shutter for the burner was not adjusted properly. There were carbon deposits on the burner and air shutter.	Lack of maintenance	Recreational (Cabin)	Refrigerator, cook top/stove	Refrigerator	Cook top/ stove	Propane
24-Oct-08	Charlie Lake	2	0	1	1	Two people were affected by CO.	Faulty mobile home gas furnace.	Equipment failure	Residential	Furnace	Furnace	-	Natural gas
29-Nov-08	Langley	2	0	2	0	Two people were treated for CO poisoning.	A gas contractor inspected the furnace and found a crack in the heat exchanger. The heat exchanger failed due to the age of the equipment and lack of service.	Lack of maintenance	Residential	Furnace	Furnace	-	Natural gas
6-Dec-08	Burnaby	0	0	0	0	The utility responded to a CO alarm call.	CO source was determined to be the roof top air handling unit. Three power-vented boilers were 20ft away on the same wall as the air handling unit; combustion products were drawn into the air intake.	Combustion products unable to vent	Residential	Roof top air handling unit	Roof top air handling unit	-	Natural gas
3-Jan-09	Surrey	0	0	0	0	A person awoke to found their residence filling with smoke. Although it was determined that the smoke originated from combustible debris left in the furnace, further investigation identified several performance issues with the furnace.	The installer failed to remove the paper or cardboard at the furnace warm air plenum. The installer was not a qualified fitter and the contractor was not licensed.	Regulated work by unqualified person	Residential	Furnace	Furnace	-	Natural gas
30-Jan-09	Dawson Creek	4	0	0	4	A gas leak was reported to the fire department. Inspection revealed furnace was producing CO.	The return air had been removed and terminated within the furnace room. The return air caused the furnace to back-vent and allowed combustion products to enter the building.	Combustion products unable to vent	Commercial	Furnace	Furnace	-	Natural gas

# Carbon Monoxide Incidents (2007 - 2015)

**TABLE 2: CARBON MONOXIDE INCIDENT INVESTIGATIONS (CONTINUED)**

INCIDENT DATE	CITY	INJURY TYPE				INCIDENT DESCRIPTION	POSSIBLE CAUSE(S), CONTRIBUTING FACTOR(S) AND DESCRIPTIONS	CAUSE CATEGORY	OCCUPANCY/ PREMISE TYPE	EQUIPMENT			
		TOTAL INJURED/AFFECTED	FATAL INJURY	HOSPITALIZED/HOSPITAL VISIT RECOMMENDED	NO INJURY REPORTED BUT AFFECTED/DISPLACED					IDENTIFIED IN INVESTIGATION	SOURCE OF CO	POSSIBLE SOURCE OF CO	GAS TYPE
2-Feb-09	Merritt	5	0	0	5	Five people experienced effects of CO.	Heat exchangers on the pool boilers were plugged due to lack of maintenance. Venting was restricted and spilled from the appliances. The door was propped in an open position, allowing vent gases/combustion products to be drawn from the mechanical room into the common pool area.	Lack of maintenance	Commercial	Pool boiler	Pool boiler	-	Natural gas
26-Oct-09	Surrey	3	0	0	3	Complaints of CO symptoms affecting three people.	A lower and upper suite was found with gas heating appliance exhaust vents not connected to the main vent. When in operation, the appliance's exhaust gases would enter the dwelling. Occupants were unaware of the unsafe condition until advised by the utility technician. Condition could have existed for five months.	Combustion products unable to vent	Residential	Hot water heater, hot water boiler	-	Hot water heater, hot water boiler	Natural gas
27-Nov-09	Burns Lake	2	1	1	0	One person died from CO poisoning; another person was hospitalized.	An exhaust power venter was improperly installed on an existing natural gas boiler. The venter was installed by a registered gas contractor approximately two months prior to the incident; the manufacturer's instructions were not followed. Investigation revealed that the venter ran 50% of the time while the boiler was fired; otherwise, the boiler spilled combustion products into the residence.	Incorrect installation	Residential	Fireplace, boiler	Fireplace, boiler	-	Natural gas
14-Dec-09	Delta	0	0	0	0	A utility technician shut down a gas furnace after a high concentration of CO was detected.	(Not described)	Unable to determine cause	Residential	Furnace	Furnace	-	Natural gas
29-Dec-09	Kamloops	0	0	0	0	People phoned emergency services when their CO detector sounded.	The installation is over 20 years old and does not meet current code requirements. The change room had the combustion air supply blocked off to prevent cold air from freezing the water lines in the room and an interior door to the building was left open. The negative pressure in the building (house) and lack of an air supply to the room caused the back-drafting.	Combustion products unable to vent	Residential	Pool boiler	Pool boiler	-	Natural gas
4-Jan-10	Prince George	1	0	0	1	A person experienced CO poisoning after CO detector alarms sounded.	Testing found that the hot water heater was spilling combustion products resulting in an elevated CO level. The hot water heater displayed evidence of corrosion and inadequate maintenance. A passive 4" combustion air source was located in the equipment room in addition to the combustion air grille located in the supply plenum of the furnace. The furnace return air ducting was reasonably tight, the filter access had no cover. No indication of back-drafting at the appliance draft hoods.	Lack of maintenance	Residential	Hot water heater, furnace	Hot water heater	Furnace	Natural gas
15-Mar-10	Vernon	1	0	0	1	A person experienced symptoms of CO exposure.	The furnace was enclosed in a small space; no combustion air. There was a 6" hole in the return air duct close to the burner. The lack of combustion air and large opening in the return air plenum caused a negative pressure in the furnace space, causing flame rollout and incomplete combustion, and distribution of the combustion products throughout the premise.	Combustion products unable to vent	Residential	Furnace	Furnace	-	Natural gas
18-Apr-10	Prince Rupert	2	0	0	2	Two people were taken to hospital for carbon monoxide poisoning.	The vent was dislodged from the boiler.	Combustion products unable to vent	Residential	Boiler	Boiler	-	Natural gas
20-Apr-10	Chemainus	1	0	0	1	A hospital test revealed that a person had an elevated CO.	The utility technician measured CO coming from the dual flame burner on a dual fuel range with a gas cook top. The dual flame burner had a glass centre. When the burner is "on," the flame seemed to impinge on the glass, producing CO with or without a pot or pan on it. The other three burners produced 40ppm CO on start up and reduced to negligible when warm. Owner was not using the microwave exhaust fan when using the range.	Combustion products unable to vent	Residential	Dual fuel range	Dual fuel range	-	Natural gas
19-Aug-10	Victoria	0	0	0	0	The fire department responded to an odour call and CO detector alarm call.	The gas water heater serviced three suites. The atmospheric water heater was vented into a dilapidated chimney that served the entire building. The 3" chimney vent connector was taped into the main chimney; no liner in the chimney. There was no combustion air into the common suite where the water heater was located.	Incorrect installation	Residential	Water heater	Water heater	-	Natural gas
14-Oct-10	Agassiz	1	0	0	1	Emergency services were called when a person was found unresponsive.	The appliances appeared that they have not been serviced. The masonry chimney was completely plugged where the furnace connects to the vent connector. The vent connector from the furnace was partially plugged by debris from the masonry chimney. The furnace had large rust particles from the heat exchanger laying across the burner. It is possible that the furnace heat exchanger had holes in it.	Lack of maintenance	Residential	Furnace	Furnace	-	Natural gas
20-Oct-10	West Vancouver	0	0	0	0	A water heater was damaged by a home made burner assembly.	A person assembled a makeshift burner to keep the water hot after the utility had plugged the fuel supply. The home-made hose and burner assembly was not secured to the water heater. The orifice was not secured to the burner and was likely to have caused severe damage and/or injuries. Pets could have dislodged the orifice, which could have caused the basement to fill with propane gas.	Intentional bypass of safety measures	Residential	Water heater, camp stove burner	Water heater, camp stove burner	-	Natural gas
12-Dec-10	Kelowna	2	1	1	0	One person died from suspected CO poisoning. A second person was hospitalized for treatment.	The furnace fan and/or dryer put the home into a negative pressure condition which caused the fireplace B-vent to down draft. The furnace duct system in the insulation space under the premise was not tightly sealed and caused a substantial negative pressure in the home when the furnace air circulation fan was operating. The fire place appeared to be in good condition during a visual check. The fireplace was disassembled and it was noted that there was soot on the ceramic log set. The centre log had damaged retaining tabs which allowed the log to fall against the front log, restricting the flame path and causing the flame to be impinged. This caused the soot and CO.	Incorrect installation	Residential	Furnace, fireplace	Furnace, fireplace	-	Natural gas
25-Jan-11	Squamish	0	0	0	0	A rooftop heating unit developed corroded and plugged burners. Excessive debris accumulated in the combustion chamber.	Lack of maintenance over time caused unit deterioration to point where critical components were corroded, holes were created.	Lack of maintenance	Commercial	Roof top heating unit	Roof top heating unit	-	Natural gas
30-Jan-11	Cumberland	0	0	0	0	Fire-side boiler explosion.	Flue gas analysis on boiler #2 indicated the boiler was in a poor state of air-gas ratio. The boiler was producing more than 2000ppm CO at high fire. The explosion was consistent with an off-cycle combustible explosion.	Poor air-gas ratio	Commercial	Boiler	Boiler	-	Natural gas
4-Feb-11	Dawson Creek	0	0	0	0	Combustion products entered into a home after the flue separated.	The flue collar from the flue liner separated from the base tee of the flue assembly.	Combustion products unable to vent	Residential	Furnace, hot water tank	Furnace, hot water tank	-	Natural gas

# Carbon Monoxide Incidents (2007 - 2015)

**TABLE 2: CARBON MONOXIDE INCIDENT INVESTIGATIONS (CONTINUED)**

INCIDENT DATE	CITY	INJURY TYPE				INCIDENT DESCRIPTION	POSSIBLE CAUSE(S), CONTRIBUTING FACTOR(S) AND DESCRIPTIONS	CAUSE CATEGORY	OCCUPANCY/ PREMISE TYPE	EQUIPMENT			
		TOTAL INJURED/ AFFECTED	FATAL INJURY	HOSPITALIZED/ HOSPITAL VISIT RECOMMENDED	NO INJURY REPORTED BUT AFFECTED/ DISPLACED					IDENTIFIED IN INVESTIGATION	SOURCE OF CO	POSSIBLE SOURCE OF CO	GAS TYPE
28-Mar-11	Vancouver	1	0	1	0	The utility responded to a gas odour call. A person was sent to hospital.	Venting on unit heaters had holes due to rusting. Investigation revealed that the common venting for the unit heaters did not meet code requirements.	Combustion products unable to vent	Commercial	Unit heaters	Unit heaters	-	Natural gas
23-Aug-11	Surrey	0	0	0	0	On advise from the utility, a person reported an incident involving the unsafe operation of a gas water heater.	Valve failed	Component failure	Residential	Water heater	Water heater	-	Natural gas
17-Oct-11	Prince George	4	0	4	0	Four people experienced CO symptoms	The water heater was installed in 2008 but recently was experiencing pilot outages. The furnace's combustion blower was not tight, the exhaust vent coupler was not tightened. There appeared to be a lack of service on the water heater and lack of combustion air.	Equipment failure	Residential	Water heater, furnace	Water heater	Furnace	Natural gas
5-Dec-11	Armstrong	1	0	0	1	A person experienced CO symptoms	The utility found high levels of CO at the top heat grill to the fireplace.	Unable to determine cause	Residential	Fireplace	Fireplace	-	Natural gas
22-Dec-11	Penticton	2	0	0	2	Two people contacted the utility when their CO detector sounded.	Lack of maintenance of the furnace caused the appliance to produce high levels of CO in the flue gas. The combination of the plugged fresh air intake and the use of the wood burning appliances in the home caused a negative condition. This negative did not allow the furnace to vent properly spilling more than 300ppm of CO into the basement. The CO was circulated throughout the home causing the CO poisoning symptoms.	Lack of maintenance	Residential	Furnace	Furnace	-	Natural gas
24-Dec-11	Whalley	0	0	0	0	The utility responded to an odour call.	Short B vent height results in poor stack action which occasionally results in the products of combustion from the water heaters spilling into the mechanical room.	Combustion products unable to vent	Residential	Water heaters	Water heaters	-	Natural gas
7-Jan-12	Langley	0	0	0	0	The utility responded to an odour call at a residence.	The utility technician confirmed that the furnace was not venting correctly and spilling CO into the residence. Insufficient gas supply caused buildup of carbon within burner. The appliance was being supplied by gas found to be bypassing a gas meter shut-off valve.	Equipment failure	Residential	Furnace	Furnace	-	Natural gas
7-Feb-12	Langley	5	0	5	0	People felt ill in their home and contacted emergency services.	Type-B vent termination cap corroded and collapsed onto the vent pipe, causing flue blockage and spillage of combustion products to spill into the residence.	Vent obstructed; Combustion products unable to vent	Residential	Boiler, water heater	-	Boiler, water heater	Natural gas
22-Feb-12	Kelowna	0	0	0	0	The fire department responded to a CO alarm at a residence.	It appears that an unqualified technician was working on the water heater two days prior to the incident taking place. The individual was called by the owner to repair a water leak and left the water heater running knowing that a part of the venting system was faulty / leaking. The individual intended to let the water heater running until the part came in which created an unsafe situation.	Regulated work by unqualified person	Residential	Water heater	-	Water heater	Natural gas
17-Mar-12	Mission	0	0	0	0	The utility responded to an odour call.	Plugged vent connector; The furnace draft hood outlet was found plugged with fibreglass insulation. The person advised the GSO that a new microwave and exhaust fan was installed. The B-vent (located above the furnace) appeared that it had been relocated from its original location. A 'ball' of fibreglass insulation was found in the vent connector. It is possible that the previous owner plugged the connector to prevent renovation debris from entering the furnace when it was moved, and had forgotten to remove the debris.	Vent obstructed; Combustion products unable to vent	Residential	Furnace	-	Furnace	Natural gas
1-May-12	Osoyoos	1	0	1	0	A person was sent to hospital for CO exposure.	Appliance installed with non-compliant venting and air requirements.	Incorrect installation	Residential	Furnace	-	Furnace	Natural gas
25-Jul-12	Salmo	3	0	1	0	Three people were treated at hospital for CO exposure.	It was not determined why the furnace was producing CO. The vent and chimney were clear; combustion products were spilling from the draft diverter. The furnace condition was poor; the heat exchanger appeared to be corroded. Cracks in the heat exchanger were present.	Unable to determine cause	Residential	Furnace	Furnace	-	Natural gas
29-Aug-12	Nelson	0	0	0	0	The utility responded to a CO alarm at a residence.	"Water heater over-fired"; "The home is at the base of a mountain there were high winds and a cool down draft coming off the mountain, coupled with tall cedar trees surrounding this home providing a high probability of a down draft at the gas vent. I suspect that the down drafting caused the products of combustions to spill into the home."	Wind created down-draft	Residential	Water heater	Water heater	-	Natural gas
20-Oct-12	Smithers	0	0	0	0	The utility responded to an odour call.	Appliance venting was not finished per regulation. The B vent was not insulated and framed per regulation. Also, the boiler could not vent properly because the hot water tank was replaced with an electric tank which "compounded the stack action."	Venting "was not finished per regulation"	Residential	Boiler	Boiler	-	Natural gas
24-Oct-12	Vancouver	0	0	0	0	The utility responded to an odour call.	The exhaust fan was not working properly.	Equipment not operating	Commercial	Stock pot	Stock pot	-	Natural gas
31-Oct-12	Abbotsford	0	0	0	5	People were exposed to CO.	Unqualified, not knowledgeable person performing regulated work.	Regulated work by unqualified person	Residential	Furnace	Furnace	-	Natural gas
29-Nov-12	West Vancouver	0	0	0	0	An exhaust vent had dislodged, allowing combustion products to be vented into the residence.	Pipe connection dislodged due to the sealant failing to adhere the plastic. The venting was well supported, and there is evidence that both the recommended primer and adhesive was used. It is possible that the elbow was impacted by a person or thing in the area leading to the disconnection. It is also possible the adhesives were subject to some kind of contamination or compromise at the time of application that allowed them to fail (such as moisture, grease, or oil), although none of this was evident at the time of inspection.	Venting pipe connection dislodged	Residential	Water heater, furnace	Water heater, furnace	-	Natural gas
16-Jan-13	Salmon Arm	0	0	0	0	The utility responded to a CO alarm at a single-family residence.	Down-drafting appliance vent and obstructed flue. The investigation revealed that when the dryer or kitchen fan was turned on, the furnace and hot water heater would spill flue products.	Combustion products unable to vent	Residential	Furnace, Hot water heater	Furnace, hot water heater	-	Natural gas



# Carbon Monoxide Incidents (2007 - 2015)

**TABLE 2: CARBON MONOXIDE INCIDENT INVESTIGATIONS (CONTINUED)**

INCIDENT DATE	CITY	INJURY TYPE				INCIDENT DESCRIPTION	POSSIBLE CAUSE(S), CONTRIBUTING FACTOR(S) AND DESCRIPTIONS	CAUSE CATEGORY	OCCUPANCY/ PREMISE TYPE	EQUIPMENT			
		TOTAL INJURED/ AFFECTED	FATAL INJURY	HOSPITALIZED/ HOSPITAL VISIT RECOMMENDED	NO INJURY REPORTED BUT AFFECTED/ DISPLACED					IDENTIFIED IN INVESTIGATION	SOURCE OF CO	POSSIBLE SOURCE OF CO	GAS TYPE
18-Jan-13	Salmon Arm	5	0	5	0	The utility responded to a CO alarm at a multi-family residence. The utility technician found 200ppm ambient CO in the residence.	A 20-year old high efficiency furnace had a damaged heat exchanger causing high levels of CO in the furnace flue. A one-inch hole had been accidentally drilled through the cell core ABS plastic furnace vent (about 15 years ago). The heat exchanger corrosion and CO in the vent of this type and age of appliance may be common, but with an intact vent pipe, the CO would not usually enter the residence.	Incorrect installation	Residential	Furnace	Furnace	-	Natural gas
2-Feb-13	Vernon	1	0	0	1	Elevated levels of CO were reported at a residence.	Kitchen exhaust fans in tight construction homes caused downdraft of B-vent, allowing flue products from the furnace to spill through the water heater draft hood. Combustion airflexible duct through the roof did not allow sufficient replacement air to make up for the exhaust fan draw.	Combustion products unable to vent	Residential	Furnace	Furnace	-	Natural gas
1-May-13	Princeton	1	1	0	0	A person died from carbon monoxide poisoning.	The propane system and appliances were installed by an unqualified individual. The propane RV refrigerator was installed indoors not vented to outdoors, creating hazardous levels of carbon monoxide.	Regulated work by unqualified person	Residential - non primary (cabin)	Refrigerator, lanterns	Refrigerator	Lanterns	Propane
26-May-13	Burnaby	2	2	0	0	Two people died from CO exposure in an industrial trailer used as living quarters.	Use of a propane generator in an enclosed space.	Unsafe use of equipment	Converted industrial	Generator	Generator	-	Propane
6-Jun-13	West Vancouver	4	0	0	4	The utility responded to a gas leak call and detected elevated levels of CO at a residence. The utility technician discovered a leak at a flair fitting on the gas manifold.	The B-vent piping was positively pressurized by a vent fan. The installation was not completed to the manufacturer's specifications, causing leakage.	Incorrect installation	Residential	Boiler	Boiler	-	Natural gas
21-Jul-13	Canoe	4	0	4	0	The utility responded to a CO alarm at a residence.	The gas system in the home was incorrectly installed. The water heater was creating excessive amounts of CO. The home owner temporarily installed a portable air conditioner unit which placed the home into a negative pressure condition which caused the water heater vent to spill CO into the home. The original installation included a ventilation panel through the furnace room door, allowing the negative pressure in the home to affect the venting of the water heater.	Incorrect installation	Residential	Furnace, water heater	Water heater	Furnace	Natural gas
4-Oct-13	Cache Creek	1	1	0	0	A person was found deceased in a cargo trailer which was converted into a living space.	Testing of the furnace suggest CO poisoning if the unit was occupied and furnace was used.	Unsafe use of equipment	Converted industrial	Furnace, range	Furnace	Range	Propane
11-Nov-13	Surrey	1	0	1	0	The utility responded to a CO alarm at a residence.	A malfunctioning furnace created excess CO. The furnace had not received regular maintenance by a qualified individual.	Lack of maintenance	Residential	Furnace	Furnace	-	Natural gas
13-Dec-13	Surrey	0	0	0	0	The fire department and utility responded to a CO alarm at a residence.	The furnace was found to have a defective heat exchanger allowing carbon monoxide to enter the home.	Component failure	Residential	Furnace	Furnace	-	Natural gas
15-Dec-13	Surrey	3	0	3	0	The utility responded to a CO call.	Plugged heat exchanger on hot water boiler caused combustion products to spill into the residence.	Lack of maintenance	Residential	Boiler, water heater	Boiler, water heater	-	Natural gas
12-Jan-14	Surrey	1	0	0	1	The fire department responded to a CO alarm at a residence. The utility technician found that CO was entering the residence from a connection in the boiler's venting that had separated.	A Weil McLain Gold series boiler was installed several years ago without a permit. The boiler is side-vented (Category III) with B-type vent. The venting material should be the approved pressure type vent (SafeT vent). The B-vent was pressed into the B-Vent 90 and held together with foil tape. The connection had separated, allowing the positive pressure vent gases to enter the boilerspace and migrate into the residence.	Incorrect installation	Residential	Boiler	Boiler	-	Natural gas
16-Mar-14	Enderby	1	0	1	0	The CO detector in the home was going off intermittently. The homeowner had been ignoring the alarm, thinking that the CO detector was malfunctioning. The homeowner awoke feeling dizzy and disoriented and called emergency services.	A furnace spilled CO into a home. The gas contractor identified gas pressure issues caused by a second-stage regulator vent line that was plugged with insects. The gas pressure was floating between 7 and 22 inches water column due to the issue with the 50-year old regulator	Vent obstructed; Combustion products unable to vent	Residential	Furnace	Furnace	-	Natural gas
10-Sep-14	Saltspring Island	2	0	2	0	Tenants in a multi-family residence experienced dizziness and nausea after the installation and use of a new gas range.	The natural gas range was installed by the homeowner and converted to propane by the tenant. Neither the homeowner nor tenant were not qualified to perform regulated work. There were no permits on record for the installation and/or conversion.  The range had been installed with a copper connector. The connector had been crimped-over during removal (or installation) making proper testing of the appliance impossible. It was reported that one of the propane orifices for one of the top burners was lost during the conversion and the natural gas orifice was left in its place.  Two other gas appliances were observed in the suite: an on-demand hot water tank, and a central furnace, which was not in use at the time of the incident. Both appliances were assessed and no CO was observed.	Unqualified persons performing regulated work	Residential	Range, hot water tank, furnace	Range	-	Propane
17-Sep-14	French Creek	1	0	1	0	The fire department responded to a CO alarm.	A furnace created CO as a result of a cracked or plugged heat exchanger. The filter door was missing, allowing products of combustion to be circulated through the living space.	Component failure	Residential	Furnace	Furnace	-	Natural gas
16-Nov-14	Abbotsford	2	0	2	0	Two people were sent to hospital after experiencing symptoms of CO exposure. Emergency services (ambulance attendants, utility technicians) detected elevated CO readings in the residence.	The top rain cap was found to be corroded to the point that the top lid of the rain cap collapsed on the top of the vent stack, blocking all combustion products from escaping. This condition caused the flue products to migrate back into the combustion chamber, leading to incomplete combustion and the generation of CO which then spilled into the residence.	Corrosion	Residential	Furnace	Furnace	-	Natural gas

# Carbon Monoxide Incidents (2007 - 2015)

**TABLE 2: CARBON MONOXIDE INCIDENT INVESTIGATIONS (CONTINUED)**

INCIDENT DATE	CITY	INJURY TYPE				INCIDENT DESCRIPTION	POSSIBLE CAUSE(S), CONTRIBUTING FACTOR(S) AND DESCRIPTIONS	CAUSE CATEGORY	OCCUPANCY/ PREMISE TYPE	EQUIPMENT			
		TOTAL INJURED/AFFECTED	FATAL INJURY	HOSPITALIZED/HOSPITAL VISIT RECOMMENDED	NO INJURY REPORTED BUT AFFECTED/DISPLACED					IDENTIFIED IN INVESTIGATION	SOURCE OF CO	POSSIBLE SOURCE OF CO	GAS TYPE
22-Nov-14	Revelstoke	0	0	0	0	A boiler was not operating properly and was creating high levels of carbon monoxide.	A wall-hung boiler was installed in a new home. The vent was not installed correctly. The vent had a joint near the boiler flue outlet that was not secured in any way. The gas fitter did not follow the boiler manufacturers venting type or vent tightness testing instructions. The gas fitter did not secure the vent transition near the boiler flue collar connection, which allowed the vent to become disconnected from the boiler. The boiler was rated and certified for use with both natural gas or propane gas. There is no conversion kit required to change fuel type. The original instruction manual for the boiler appears to have incomplete fuel conversion procedure instructions. It is likely that incorrect fuel conversion and burner set up caused the boiler to create high concentrations of carbon monoxide. The boiler has a rated input of 225,000 btuh, and does not require a class A gas fitter to perform commissioning or fuel conversion. The type of training received for class B gas fitters may not be adequate in many cases to ensure safe set up of this type of fuel system.	Incorrect installation	Residential	Boiler	Boiler	-	Propane
26-Nov-14	North Vancouver	6	0	6	0	Six people were taken to hospital and treated for suspected carbon monoxide poisoning. Several individuals reported feeling nauseous with persistent headaches and dizziness throughout the day. Individuals observed a strange smell and contacted the gas utility. Upon a site investigation the utility's technician recorded elevated levels of carbon monoxide in the combustion gases spilling from the furnace.	The venting system did not terminate to the outdoors. Combustion products were vented into the attic space. The combustion air plenum was not hooked up to the top of the furnace and terminated in the attic space adjacent to the vent. This configuration would have allowed the burners to be affected by the reduced pressure condition in the closet. Also the combustion air plenum would have acted as a pathway for air and combustion products to be drawn down into the closet space from the attic. A door was installed in front of the furnace's return air grill. When the furnace was turned ON, the furnace was unable to draw enough air from the small return air grills that had been cut into the closet walls creating a low pressure condition inside the closet. Any air or products of combustion that were drawn into the closet and in through the furnaces return air intake would have been distributed throughout the trailer through the furnaces supply ducting.	Insufficient combustion air	Commercial	Furnace	Furnace	-	Natural gas
29-Nov-14	Winfield	3	0	3	0	Three people were sleeping when they were awoken by their CO alarm sounding. The occupants opened the windows to ventilate the house. The CO alarm sounded again around 4 hours after the initial alarm. The occupants were sent to hospital for treatment and observation.	The seal around the fireplace glass was found to be leaking CO into the basement of the house. As well, the screws holding the fireplace glass in place were found to be loose.	Equipment failure	Residential	Fireplace, furnace	Fireplace	-	Natural gas
30-Nov-14	Surrey	15	0	15	0	Fifteen residents were sent to hospital for evaluation and treatment for carbon monoxide poisoning.	The boiler venting was installed incorrectly permitting the products of combustion from the boiler to enter the home. In October 2014 a contractor installed a high efficiency condensing boiler in the basement of the home. The CPVC exhaust venting was installed inside an existing metal duct. The metal duct was open at both ends permitting products of combustion to enter the basement through the duct.	Incorrect installation	Residential	Boiler	Boiler	-	Natural gas
2-Dec-14	Surrey	3	0	0	3	A food processing facility was found to have a high concentration of CO within the facility. The utility technicians responded after employees reported feeling unwell.	The water heater was not maintained and the noted spillage from the water heater's draft hood was not addressed. An atmospheric water heater was installed in the mechanical room, next to a gas-fired steam boiler. The mechanical room is open to the rest of the building. The combustion air for the room is supplied by a duct from the roof and terminates next to the hot water heater. The building has two commercial cooking areas with combination make-up air and exhaust systems. The water heater appears to have been spilling products of combustion into the mechanical room for some time. An employee reported that he noticed heat coming from the draft hood of the water heater. Over a period of time, the water heater heat exchanger plugged up with soot.	Lack of maintenance	Commercial	Water heater, boiler, pan washer	Water heater	-	Natural gas
2-Dec-14	Surrey	0	0	0	0	A homeowner was alerted by their carbon monoxide detector and contacted the utility.	The technician found that the hot water boiler heat exchanger was plugged and was producing the CO that entered the home.	Equipment failure	Residential	Boiler	Boiler	-	Natural gas
4-Dec-14	Surrey	1	0	0	1	The utility responded to a report of a gas odour. The return air supply duct had been covered with a solid panel causing a negative condition in the water heater/furnace closet which allowed the products of combustion from the water heater to enter the air system into the dwelling unit through the air filter opening in the furnace ducting. The odor was from the products of combustion. There was approximately 25 ppm carbon monoxide in the dwelling unit where the return air had been sealed.	The return air supply ducts from each of the units in a housing complex were originally supplied with a solid, sound insulated panel that was spaced away from the return air duct opening with screws and spacers. A furnace filter was installed in the opening between the panel and the return air duct opening. There was also a filter rack installed in the return air duct above the furnace. An employee had secured the panel in place without the spacers completely sealing the return air duct opening into the dwelling unit. The venting configuration did not permit the water heater to vent and there was an indication of continual spillage from the water heater draft hood. The products of combustion from the water heater were drawn into the furnace return air through the filter opening above the furnace. The combustion air for the furnace was originally provided via a 4" duct from the outside into the return air of the furnace. The outside opening was not visible as new soffits had been installed. There was also a duct into the crawlspace did not appear to be connected to an outdoor air source.	Venting configuration did not allow combustion products to vent	Residential	Furnace, water heater	Water heater	-	Natural gas
12-Dec-14	Surrey	2	0	0	2	The fire department and utility responded to a CO alarm at a residence.	The hot water heating boiler had not been serviced in at least five years. The boiler burners and heat exchanger became dirty, producing high levels of carbon monoxide in the products of combustion. Some of the combustion products spilled from the boiler venting system into the home.	Lack of maintenance	Residential	Boiler	Boiler	-	Natural gas
20-Dec-14	Port Alberni	2	0	2	0	The fire department responded to a CO alarm at a residence. The homeowners also reported feeling ill recently and were advised by first responders to be evaluated at hospital.	Following the incident, a utility technician observed CO readings in the supply ducting. It is suspected the cause to be a cracked heat exchanger due to CO readings in the plenum.	Equipment failure	Residential	Furnace	-	Furnace	Natural gas

# Carbon Monoxide Incidents (2007 - 2015)

**TABLE 2: CARBON MONOXIDE INCIDENT INVESTIGATIONS (CONTINUED)**

INCIDENT DATE	CITY	INJURY TYPE				INCIDENT DESCRIPTION	POSSIBLE CAUSE(S), CONTRIBUTING FACTOR(S) AND DESCRIPTIONS	CAUSE CATEGORY	OCCUPANCY/ PREMISE TYPE	EQUIPMENT			
		TOTAL INJURED/ AFFECTED	FATAL INJURY	HOSPITALIZED/ HOSPITAL VISIT RECOMMENDED	NO INJURY REPORTED BUT AFFECTED/ DISPLACED					IDENTIFIED IN INVESTIGATION	SOURCE OF CO	POSSIBLE SOURCE OF CO	GAS TYPE
13-Jan-15	Surrey	1	0	1	0	Emergency services responded to a CO alarm at a multi-family residence (townhouse units). The utility technician found low levels of CO but could not locate the source of the CO in the townhouse. In the adjacent unit, the technician measured high CO levels produced by the boiler.	It was reported that the primary air adjustments on the boiler's burners were opened too much. This situation likely was likely created when the boiler was previously serviced.	Inadequate service/maintenance	Residential	Boiler	Boiler	-	Natural gas
17-Jan-15	Chilliwack	5	0	5	0	After experiencing symptoms of vomiting, nausea and headaches, two residents were sent to hospital. The three other residents were also sent to hospital for testing.	The furnace heat exchanger was found to have signs of corrosion. The furnace burners were dirty and appeared to have a yellow and lazy flame pattern.	Insufficient maintenance	Residential	Furnace, dryer	Furnace	-	Natural gas
24-Jan-15	Surrey	0	0	0	0	The utility responded to a CO alarm at a residence.	The exhaust vent and combustion air supply were terminated using a concentric vent termination. The termination was installed less than 12" above the finished grade which permitted combustion products to be reintroduced into the water heater burner. This increased the carbon monoxide in the exhaust gases.	Incorrect installation	Residential	Water heater	Water heater	-	Natural gas
17-Mar-15	Charlie Lake	3	0	3	0	Residents contacted the utility after experiencing headaches. The utility technician measured 190 ppm of carbon monoxide.	(Not described)	Unable to determine cause	Residential	Furnace	-	Furnace	Natural gas
05-May-15	Coquitlam	1	0	1	0	A resident went to hospital for suspected CO poisoning. The fire department measured 70 ppm CO in the water heater room and 10ppm in the rest of the residence.	Exhaust from a gas appliance spilled into a dwelling unit. When the water heater was installed, the combustion air vented to the exterior, however the exhaust was venting into the dwelling unit. The start-up and testing procedures were not followed. Start-up testing procedures are intended to ensure the unit is operating in a safe condition).	Incorrect installation	Residential	Water heater	Water heater	-	Natural gas
15-Nov-15	Langford	1	0	1	0	Emergency services responded to a CO alarm. Air tests measured levels of 25-50ppm carbon monoxide in free air in the space and over 100ppm near the two fireplaces	Inspection of the fireplace showed a poorly aligned seal on the fireplace door, allowing combustion products to escape into the occupied space.	Equipment failure - component failure	Residential	Fireplace	Fireplace	-	Natural gas
12-Dec-15	Surrey	0	0	0	0	A gas odour was reported.	The vent connector from the boiler and the water heater had been connected to the combustion air supply duct instead of the B vent. The vent connector had signs of sooting and the combustion air duct was sooted, as well.	Incorrect installation	Residential	Boiler, water heater	Boiler, water heater	-	Natural gas
13-Dec-15	Surrey	2	0	1	1	The utility responded to a CO alarm at a residence.	Suspected plugged heat exchanger	Equipment - component failure	Residential	Boiler, water heater	-	Boiler, water heater	Natural gas