
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.

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.

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 ‘minor 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.

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.

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

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

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.
The 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 BCSSA investigation.

### TABLE 2: CARBON MONOXIDE INCIDENT INVESTIGATIONS

<table>
<thead>
<tr>
<th>INCIDENT DATE</th>
<th>CITY</th>
<th>TOTAL INJURED</th>
<th>TOTAL INJURED</th>
<th>HOSPITALIZED</th>
<th>HOSPITALIZED</th>
<th>TREATMENT RECOMMENDED</th>
<th>TREATMENT RECOMMENDED</th>
<th>NO INJURY REPORTED</th>
<th>NO INJURY REPORTED</th>
<th>AFFECTED</th>
<th>INJURED/INJURY</th>
<th>INJURY TYPE</th>
<th>PREMISE</th>
<th>OCCUPANCY/</th>
<th>SOURCE OF CO</th>
<th>GAS TYPE</th>
<th>EQUIPMENT</th>
<th>SOURCE OF CO</th>
<th>GAS TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-Mar-07</td>
<td>Surrey</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
<td>A person was taken to hospital and treated for CO poisoning.</td>
<td>Equipment failure Residential Furnace, water heater Furnace Water heater Natural gas</td>
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</tr>
<tr>
<td>11-Apr-07</td>
<td>New Westminster</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td>An odour was reported to the fire department.</td>
<td>Equipment failure Residential Furnace, water heater Furnace Natural gas</td>
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<tr>
<td>20-Apr-07</td>
<td>Prince George</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td></td>
<td>A gas utility responded to an odour call.</td>
<td>Component failure Residential Furnace Furnace Natural gas</td>
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<tr>
<td>2-Jul-07</td>
<td>Vernon</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td></td>
<td>Two people died from CO exposure.</td>
<td>Incorrect installation Residential Refrigerator Refrigerator Propane</td>
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<tr>
<td>6-Jul-07</td>
<td>New Westminster</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td>A person contacted his gas contractor after noticing die-like condensation on the basement walls.</td>
<td>Vent obstructed Combustion products unable to vent Residential Pool boiler Pool boiler Natural gas</td>
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<tr>
<td>18-Jul-07</td>
<td>Duncan</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
<td>A person was taken to hospital for CO poisoning.</td>
<td>Equipment failure Residential Furnace Furnace Natural gas</td>
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<tr>
<td>5-Oct-07</td>
<td>Coquitlam</td>
<td>2</td>
<td>2</td>
<td>0</td>
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<td>Two people were taken to hospital with possible CO poisoning.</td>
<td>Equipment failure service/ replacement Residential Furnace Furnace Natural gas</td>
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<tr>
<td>27-Nov-07</td>
<td>Sun Peaks</td>
<td>6</td>
<td>0</td>
<td>0</td>
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<td>Six people were taken to hospital with CO poisoning.</td>
<td>Equipment failure Residential Boiler Boiler Natural gas</td>
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<tr>
<td>14-Dec-07</td>
<td>Pitt Meadows</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td></td>
<td>Four people were treated for CO poisoning.</td>
<td>Unable to determine cause Residential Furnace - Furnace Natural gas</td>
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<tr>
<td>26-Jan-08</td>
<td>Denman Island</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td></td>
<td>A deceased person was discovered in a burned out camping van.</td>
<td>Unable to determine cause Campervan Catalytic heater - Catalytic heater Propane</td>
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<tr>
<td>11-Apr-08</td>
<td>Vancouver</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td>A gas odour was reported to the fire department.</td>
<td>Combustion products unable to vent Commercial Fireplaces, boilers, cooking appliances, ranges Fireplaces, boilers, cooking appliances, ranges Natural gas</td>
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<tr>
<td>18-May-08</td>
<td>Armstrong</td>
<td>27</td>
<td>0</td>
<td>0</td>
<td>Teen-agers were taken to hospital for CO poisoning.</td>
<td>Combustion products unable to vent Industrial Boiler Boiler Natural gas</td>
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<tr>
<td>1-Sep-08</td>
<td>Lumby</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>Five people were taken to hospital for treatment after exposure to CO.</td>
<td>Inspection of the premises revealed a white pipe deposit and water in the firebox.</td>
<td>Lack of maintenance Residential Cook top/ stove Refrigerator Cook top/ stove Natural gas</td>
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<tr>
<td>24-Oct-08</td>
<td>Charlie Lake</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>Two people were affected by CO.</td>
<td>Faulty mobile home gas furnace.</td>
<td>Equipment failure Residential Furnace Furnace Natural gas</td>
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<tr>
<td>29-Nov-08</td>
<td>Langley</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>Two people were treated for CO poisoning.</td>
<td>A gas contractor inspected the furnace and found a crack in the heat exchanger.</td>
<td>Lack of maintenance Residential Furnace Furnace Natural gas</td>
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<tr>
<td>6-Dec-08</td>
<td>Burnaby</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>The utility responded to a CO alarm call.</td>
<td>CO source was determined to be no top air handling unit. Three power-vent boilers were 20 ft away on the same wall as the air handling unit. Combustion products were drawn into the air intake.</td>
<td>Combustion products unable to vent Residential Roof top air handling unit Roof top air handling unit Natural gas</td>
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<tr>
<td>3-Jan-09</td>
<td>Surrey</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>A person awoke to find their residence filled with smoke.</td>
<td>The installer failed to remove the paper or cardboard at the furnace warm air plenum. The installer was not a qualified filter and the contractor was not licensed.</td>
<td>Regulated work by unqualified person Residential Furnace Furnace Natural gas</td>
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<tr>
<td>30-Jan-09</td>
<td>Dawson Creek</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>A gas leak was reported to the fire department.</td>
<td>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.</td>
<td>Combustion products unable to vent Commercial Furnace Furnace Natural gas</td>
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</tbody>
</table>

TABLE 2: CARBON MONOXIDE INCIDENT INVESTIGATIONS (CONTINUED)

<table>
<thead>
<tr>
<th>INCIDENT DATE</th>
<th>CITY</th>
<th>INCIDENT DESCRIPTION</th>
<th>POSSIBLE CAUSE(S), CONTRIBUTING FACTOR(S) AND DESCRIPTIONS</th>
<th>CAUSE CATEGORY</th>
<th>OCCUPANCY/ SOURCE OF CO</th>
<th>EQUIPMENT</th>
<th>GAS TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Feb-09</td>
<td>Merritt</td>
<td>Five people experienced effects of CO. Heat exchangers on the pool burners were plugged due to lack of maintenance. Vents were 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.</td>
<td>Lack of maintenance</td>
<td>Commercial</td>
<td>Pool boiler</td>
<td>Pool boiler</td>
<td>Natural gas</td>
</tr>
<tr>
<td>28-Oct-09</td>
<td>Surrey</td>
<td>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.</td>
<td>Combustion products unable to vent</td>
<td>Residential</td>
<td>Hot water heater; hot water boiler</td>
<td>Hot water heater; hot water boiler</td>
<td>Natural gas</td>
</tr>
<tr>
<td>27-Nov-09</td>
<td>Burns Lake</td>
<td>One person died from CO poisoning; another person was hospitalised. An exhaust power vent was improperly installed on an existing natural gas boiler. The vent 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 vent ran 50% of the time while the boiler was fired; otherwise, the boiler spilled combustion products into the residence.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Fireplace, boiler</td>
<td>Fireplace, boiler</td>
<td>Natural gas</td>
</tr>
<tr>
<td>14-Dec-09</td>
<td>Delta</td>
<td>A utility technician shut down a gas furnace after a high concentration of CO was detected. (Not described)</td>
<td>Unable to determine cause</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>Natural gas</td>
</tr>
<tr>
<td>29-Dec-09</td>
<td>Kamloops</td>
<td>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.</td>
<td>Combustion products unable to vent</td>
<td>Residential</td>
<td>Pool boiler; pool boiler</td>
<td>Pool boiler</td>
<td>Natural gas</td>
</tr>
<tr>
<td>4-Jan-10</td>
<td>Prince George</td>
<td>A person experienced CO poisoning after CO detector alarm sounded.</td>
<td>Lack of maintenance</td>
<td>Residential</td>
<td>Hot water heater, furnace</td>
<td>Hot water heater, furnace</td>
<td>Natural gas</td>
</tr>
<tr>
<td>15-Mar-10</td>
<td>Vernon</td>
<td>A person experienced symptoms of CO exposure. The furnace was enclosed in a small space; no combustion air. There was a 6&quot; 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 rollover and incomplete combustion, and distribution of the combustion products throughout the premises.</td>
<td>Combustion products unable to vent</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>Natural gas</td>
</tr>
<tr>
<td>18-Apr-10</td>
<td>Prince Rupert</td>
<td>Two people were taken to hospital for carbon monoxide poisoning. The vent was disconnected from the boiler.</td>
<td>Combustion products unable to vent</td>
<td>Residential</td>
<td>Boiler</td>
<td>Boiler</td>
<td>Natural gas</td>
</tr>
<tr>
<td>20-Apr-10</td>
<td>Chemainus</td>
<td>A hospital test revealed that the 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 was a gas plenum. When the burner is on, &quot;the flame seemed to merge on the plenum, producing CO with or without a pilot or pan on start up. The other three burners produced 40ppm CO on start up and reduced to negligible levels when on. Denser was not using the main water exhaust fan when using the range.</td>
<td>Combustion products unable to vent</td>
<td>Residential</td>
<td>Dual fuel range</td>
<td>Dual fuel range</td>
<td>Natural gas</td>
</tr>
<tr>
<td>19-Aug-10</td>
<td>Victoria</td>
<td>The fire department responded to a odour call and CO detector alarm call. The gas water heater served three suites. The atmospheric water heater was vented into a disapplicated chimney that served the entire building. The 3&quot; chimney vent connector was taken into the main chimney; no liner in the chimney. There was no combustion air into the common suite where the water heater was located.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Water heater</td>
<td>Water heater</td>
<td>Natural gas</td>
</tr>
<tr>
<td>14-Oct-10</td>
<td>Agassiz</td>
<td>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 bulging across the burner. It is possible that the furnace heat exchanger had holes in it.</td>
<td>Lack of maintenance</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>Natural gas</td>
</tr>
<tr>
<td>20-Oct-10</td>
<td>West Vancouver</td>
<td>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 release of water and/or burners. The orifice could have dislodged the orifice, which could have caused the basement to fill with propane gas.</td>
<td>Intentional bypass of safety measures</td>
<td>Residential</td>
<td>Water heater, camp stove burner</td>
<td>Water heater, camp stove burner</td>
<td>Natural gas</td>
</tr>
<tr>
<td>13-Dec-10</td>
<td>Kelowna</td>
<td>One person died from suspected CO poisoning. A second person was hospitalised 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 premises 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. The caused the spoil and CO.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Furnace, fireplace</td>
<td>Furnace, fireplace</td>
<td>Natural gas</td>
</tr>
<tr>
<td>29-Jan-11</td>
<td>Squamish</td>
<td>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.</td>
<td>Lack of maintenance</td>
<td>Commercial</td>
<td>Roof top heating unit</td>
<td>Roof top heating unit</td>
<td>Natural gas</td>
</tr>
<tr>
<td>30-Jan-11</td>
<td>Cumberland</td>
<td>A commercial boiler explosion.</td>
<td>Poor air gas ratio</td>
<td>Commercial</td>
<td>Boiler</td>
<td>Boiler</td>
<td>Natural gas</td>
</tr>
<tr>
<td>4-Feb-11</td>
<td>Dawson Creek</td>
<td>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.</td>
<td>Combustion products unable to vent</td>
<td>Residential, hot water tank</td>
<td>Furnace, hot water tank</td>
<td>Furnace, hot water tank</td>
<td>Natural gas</td>
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</table>
TABLE 2: CARBON MONOXIDE INCIDENT INVESTIGATIONS (CONTINUED)

<table>
<thead>
<tr>
<th>INCIDENT DATE</th>
<th>CITY</th>
<th>TOTAL INJURED</th>
<th>FATAL INJURY</th>
<th>HOSPITALIZED</th>
<th>INJURY IDENTIFIED</th>
<th>INJURY TREATMENT</th>
<th>OCCUPANCY</th>
<th>CAUSE CATEGORY</th>
<th>EQUIPMENT</th>
<th>Possible Source of CO</th>
<th>Gas Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-Mar-11</td>
<td>Vancouver</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Combustion products Unable to vent</td>
<td>Unit heater</td>
<td>Residential</td>
<td>Natural gas</td>
</tr>
<tr>
<td>23-Aug-11</td>
<td>Surrey</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Component failure</td>
<td>Water heater</td>
<td>Water heater</td>
<td>Natural gas</td>
</tr>
<tr>
<td>17-Oct-11</td>
<td>Prince George</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Equipment failure</td>
<td>Water heater, furnace</td>
<td>Water heater, furnace</td>
<td>Natural gas</td>
</tr>
<tr>
<td>5-Dec-11</td>
<td>Armstrong</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Unable to determine causes</td>
<td>Fire place</td>
<td>Fire place</td>
<td>Natural gas</td>
</tr>
<tr>
<td>22-Dec-11</td>
<td>Pittotcan</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Lack of maintenance</td>
<td>Furnace furnaces</td>
<td>Furnace furnace</td>
<td>Natural gas</td>
</tr>
<tr>
<td>24-Dec-11</td>
<td>Whalley</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Combustion products Unable to vent</td>
<td>Water heater</td>
<td>Water heaters</td>
<td>Natural gas</td>
</tr>
<tr>
<td>7-Jan-12</td>
<td>Langley</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Equipment failure</td>
<td>Furnace furnaces</td>
<td>Furnace furnaces</td>
<td>Natural gas</td>
</tr>
<tr>
<td>7-Feb-12</td>
<td>Langley</td>
<td>5</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Vent obstructed, Combustion products Unable to vent</td>
<td>Boiler, water heater</td>
<td>Boiler, water heater</td>
<td>Natural gas</td>
</tr>
<tr>
<td>23-Feb-12</td>
<td>Kelowna</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Regulated work by unqualified person</td>
<td>Water heater</td>
<td>Water heater</td>
<td>Natural gas</td>
</tr>
<tr>
<td>17-Mar-12</td>
<td>Mission</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Vent obstructed, Combustion products Unable to vent</td>
<td>Furnace furnaces</td>
<td>Furnace furnaces</td>
<td>Natural gas</td>
</tr>
<tr>
<td>1-May-12</td>
<td>Comox</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Incorrect installation</td>
<td>Furnace furnaces</td>
<td>Furnace furnaces</td>
<td>Natural gas</td>
</tr>
<tr>
<td>25-Jul-12</td>
<td>Salmo</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Unable to determine cause</td>
<td>Furnace furnaces</td>
<td>Furnace furnaces</td>
<td>Natural gas</td>
</tr>
<tr>
<td>29-Aug-12</td>
<td>Nelson</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Wind created down-draft</td>
<td>Water heater</td>
<td>Water heater</td>
<td>Natural gas</td>
</tr>
<tr>
<td>20-Oct-12</td>
<td>Smithers</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Vending &quot;was not finished per regulation&quot;</td>
<td>Boiler</td>
<td>Boiler</td>
<td>Natural gas</td>
</tr>
<tr>
<td>24-Oct-12</td>
<td>Vancouver</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Commercial</td>
<td>Equipment not opening</td>
<td>Stock pot, stock pot</td>
<td>-</td>
<td>Natural gas</td>
</tr>
<tr>
<td>31-Oct-12</td>
<td>Abbotsford</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Commercial</td>
<td>Repair work by unqualified person</td>
<td>Furnace furnaces</td>
<td>Furnace furnaces</td>
<td>Natural gas</td>
</tr>
<tr>
<td>29-Nov-12</td>
<td>West Vancouver</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Vending pipe connection dislodged</td>
<td>Water heater, furnace</td>
<td>Water heater, furnace</td>
<td>Natural gas</td>
</tr>
<tr>
<td>16-Jan-13</td>
<td>Salmon Arm</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Residential</td>
<td>Combustion products Unable to vent</td>
<td>Furnace, Hot water heater</td>
<td>Furnace, hot water heater</td>
<td>Natural gas</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INCIDENT DATE</th>
<th>CITY</th>
<th>TOTAL INJURED AFFECTED</th>
<th>FATAL INJURY</th>
<th>HOSPITALIZED</th>
<th>VICTIM TYPE</th>
<th>CAUSE CATEGORY</th>
<th>OCCUPANCY/ INTENDED TYPE</th>
<th>IDENTIFIED IN INVESTIGATION</th>
<th>SOURCE OF CO</th>
<th>POSSIBLE SOURCE OF CO</th>
<th>GAS TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-Jan-14</td>
<td>Salmon Arm</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>The CO detector in the home was going off intermittently.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>-</td>
</tr>
<tr>
<td>2-Feb-13</td>
<td>Vernon</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>Elevated levels of CO were reported at a residence.</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>-</td>
<td>Natural gas</td>
</tr>
<tr>
<td>1-May-13</td>
<td>Princeton</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>A person died from carbon monoxide poisoning.</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>-</td>
<td>Natural gas</td>
</tr>
<tr>
<td>26-May-13</td>
<td>Burnaby</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>Two people died from CO exposure in an industrial trailer used as a living quarters.</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>-</td>
<td>Natural gas</td>
</tr>
<tr>
<td>6-Jun-13</td>
<td>West Vancouver</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>The utility responded to a CO leak call and detected elevated levels of CO at a residence. The utility technician discovered a leak at a fuel fitting on the gas manifold.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Boiler</td>
<td>Boiler</td>
<td>-</td>
</tr>
<tr>
<td>21-Jul-13</td>
<td>Carco</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>The utility responded to a CO alarm at a residence.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Furnace, water heater</td>
<td>Furnace</td>
<td>Natural gas</td>
</tr>
<tr>
<td>4-Oct-13</td>
<td>Cache Creek</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>A person was found deceased in a cargo trailer which was converted into a living space.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>-</td>
</tr>
<tr>
<td>11-Nov-13</td>
<td>Surrey</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>The utility responded to a CO alarm at a residence.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>-</td>
</tr>
<tr>
<td>13-Dec-13</td>
<td>Surrey</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>The fire department and utility responded to a CO alarm at a residence.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>-</td>
</tr>
<tr>
<td>12-Jan-14</td>
<td>Surrey</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>The fire department responded to a CO alarm at a residence.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>-</td>
</tr>
<tr>
<td>16-Mar-14</td>
<td>Endersby</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>The CO detector in the home was going off intermittently. The homeowner had been ignoring the alarm, thinking that the CO detector was malfunctioning.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>-</td>
</tr>
<tr>
<td>10-Sep-14</td>
<td>Saltspring Island</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>Tenants in a multi-family-residence experienced dizziness and nausea after the installation and use of a new gas range.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>-</td>
</tr>
<tr>
<td>17-Sep-14</td>
<td>French Creek</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>The fire department responded to a CO alarm.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>-</td>
</tr>
<tr>
<td>16-Nov-14</td>
<td>Abbotsford</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>Two people were sent to hospital after experiencing symptoms of CO exposure.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>-</td>
</tr>
</tbody>
</table>

**TABLE 2: CARBON MONOXIDE INCIDENT INVESTIGATIONS (CONTINUED)**
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 up with scum.

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 dump hood of the water heater. Over a period of time, the water heater heat exchanger plugged up with scum.

A door was installed in front of the furnace's return air grill. When the furnace was turned ON, the furnace was drawn down into the closet space from the attic.

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 plenum. Also, the combustion air plenum would have acted as a pathway for air and combustion products to be drawn down into the closed space from the attic.

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 dump hood of the water heater. Over a period of time, the water heater heat exchanger plugged up with scum.

The return air ducting that had been covered with a solid panel caused an inadequate condition in the water heater/furnace plenum which allowed the products of combustion from the hot water heater to enter the air supply into the dwelling unit through the return air filter opening in the furnace ducting. The return air was then drawn along with the combustion products from the products of combustion. There was approximately 20 ppm carbon monoxide in the dwelling unit where the return air had been sealed.

The temperature monitoring equipment was not available at the time of the investigation. The utility did not perform the required diagnostic testing for the system. The utility was not able to access the system to perform the required testing. The utility did not have access to the system to perform the required testing. The utility did not have access to the system to perform the required testing.

The utility did not perform the required diagnostic testing for the system. The utility was not able to access the system to perform the required diagnostic testing. The utility did not have access to the system to perform the required diagnostic testing. The utility did not have access to the system to perform the required diagnostic testing.

The utility did not perform the required diagnostic testing for the system. The utility was not able to access the system to perform the required diagnostic testing. The utility did not have access to the system to perform the required diagnostic testing. The utility did not have access to the system to perform the required diagnostic testing.

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The utility did not perform the required diagnostic testing for the system. The utility was not able to access the system to perform the required diagnostic testing. The utility did not have access to the system to perform the required diagnostic testing. The utility did not have access to the system to perform the required diagnostic testing.

The utility did not perform the required diagnostic testing for the system. The utility was not able to access the system to perform the required diagnostic testing. The utility did not have access to the system to perform the required diagnostic testing. The utility did not have access to the system to perform the required diagnostic testing.

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

<table>
<thead>
<tr>
<th>INCIDENT DATE</th>
<th>CITY</th>
<th>TOTAL INJURED</th>
<th>FATAL INJURY</th>
<th>HOSPITALIZED HOSPITAL VISIT RECOMMENDED</th>
<th>NO INJURY REPORTED BUT AFFECTED DISPLACED</th>
<th>INCIDENT DESCRIPTION</th>
<th>POSSIBLE CAUSE(S), CONTRIBUTING FACTOR(S) AND DESCRIPTIONS</th>
<th>CAUSE CATEGORY</th>
<th>OCCUPANCY/ PREMISE TYPE</th>
<th>IDENTIFIED IN INVESTIGATION</th>
<th>SOURCE OF CO</th>
<th>POSSIBLE SOURCE OF CO</th>
<th>GAS TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-Jan-15</td>
<td>Surrey</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>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.</td>
<td>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.</td>
<td>Inadequate service/ maintenance</td>
<td>Residential</td>
<td>Boiler, Boiler</td>
<td>-</td>
<td>Natural gas</td>
<td>-</td>
</tr>
<tr>
<td>17-Jan-15</td>
<td>Chilliwack</td>
<td>5</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>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.</td>
<td>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.</td>
<td>Insufficient maintenance</td>
<td>Residential</td>
<td>Furnace, dryer, Furnace</td>
<td>Natural gas</td>
<td>-</td>
<td>Natural gas</td>
</tr>
<tr>
<td>24-Jan-15</td>
<td>Surrey</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>The utility responded to a CO alarm at a residence.</td>
<td>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.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Water heater, Water heater</td>
<td>-</td>
<td>Natural gas</td>
<td>-</td>
</tr>
<tr>
<td>17-Mar-15</td>
<td>Charlie Lake</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>Residents contacted the utility after experiencing headaches. The utility technician measured 190 ppm of carbon monoxide.</td>
<td>[Not described]</td>
<td>Unable to determine cause</td>
<td>Residential</td>
<td>Furnace</td>
<td>Furnace</td>
<td>Natural gas</td>
<td></td>
</tr>
<tr>
<td>05-May-15</td>
<td>Coquitlam</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>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.</td>
<td>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,</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Water heater, Water heater</td>
<td>-</td>
<td>Natural gas</td>
<td>-</td>
</tr>
<tr>
<td>15-Nov-15</td>
<td>Langford</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>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.</td>
<td>[Not described]</td>
<td>Equipment failure - component failure</td>
<td>Residential</td>
<td>Fireplace, Fireplace</td>
<td>-</td>
<td>Natural gas</td>
<td>-</td>
</tr>
<tr>
<td>12-Dec-15</td>
<td>Surrey</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>A gas odour was reported.</td>
<td>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.</td>
<td>Incorrect installation</td>
<td>Residential</td>
<td>Boiler, water heater, Boiler, water heater</td>
<td>-</td>
<td>Natural gas</td>
<td>-</td>
</tr>
<tr>
<td>13-Dec-15</td>
<td>Surrey</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>The utility responded to a CO alarm at a residence.</td>
<td>Suspected plugged heat exchanger</td>
<td>Equipment failure - component failure</td>
<td>Residential</td>
<td>Boiler, water heater</td>
<td>-</td>
<td>Natural gas</td>
<td>-</td>
</tr>
</tbody>
</table>