

Incident Summary #II-1309931-2021 (#25658) (FINAL)

SUPPORTING INFORMATION	Incident Date		December 26, 2021	
	Location		Prince George	
	Regulated industry sector		Electrical - Low voltage electrical system (30V to 750V)	
	Impact	Injury	Qty injuries	1
			Injury description	One individual deceased
			Injury rating	Fatal
	Damage	Damage	Damage description	N/A
			Damage rating	None
Incident rating		Severe		
Incident overview		A worker was found unresponsive in an enclosed basement of a house under construction. There was a portable gasoline fueled electric generator in the basement supplying power to an electric heater. The generator exhausted products of combustion into the enclosed basement producing high levels of carbon monoxide.		

INVESTIGATION CONCLUSIONS	Site, system and components	The house under construction had insulated concrete foundation walls with wooden floor joists and a plywood subfloor in place (Image 1) .	
		The single entrance for the basement consisted of a window opening with a tarp covering. All other window openings were boarded over (Image 2) .	
		The gasoline fueled portable electric generator provided 120/240 Volt electricity for temporary power purposes (Image 3) . The generator has a rated output of 5.5 KVA. The generator and its manual both include hazard warnings indicating the generator is not to be used indoors due to the hazard of carbon monoxide poisoning (Images 4-8) .	
		The generator involved with this incident did not incorporate a carbon monoxide sensor and shutdown system.	
		The heater was an electric element heater with a fan supplied from a generator receptacle (Image 9) .	
		Carbon monoxide is a colourless, odourless, tasteless gas that is toxic to humans and animals (Chart 1) . Exposure to carbon monoxide interferes with the body's ability to absorb oxygen, which can result in serious illness or death (Chart 2) .	
		Rapid-onset or sudden exposure to high levels of carbon monoxide can be lethal, fast and without warning. Entering a space that has a high concentration of carbon monoxide can quickly incapacitate an occupant. In this hazardous environment there may be no opportunity to feel ill and seek to escape, potentially rendering an occupant unconscious with continued exposure to the lethal effects of carbon monoxide.	
		For more carbon monoxide information, visit Carbon monoxide safety tips .	

Incident Summary #II-1309931-2021 (#25658) (FINAL)

Failure scenario(s)	<p>The basement of the house under construction was enclosed and an electric heater fed from a gas fueled generator was in place to prevent damage to the concrete foundation walls. There was one window opening covered by a tarp and no openings for fresh air ventilation. The generator was being used inside the enclosed basement to avoid theft and to keep it quieter for neighbors, however this was contrary to the warnings on the generator and in the generator's manual (Images 4-8)</p> <p>While the generator was operating it circulated exhaust gases containing carbon monoxide into the enclosed space. The exhaust gases circulated until the concentration of carbon monoxide elevated in the space up to at least 1000 PPM but likely over that amount.</p> <p>A worker entered the sealed off basement containing the generator and was found unresponsive inside the basement approximately 3 hours later.</p>
Facts and evidence	<p>Co-worker statements</p> <ul style="list-style-type: none">• The concrete walls were made of insulated concrete form (ICF) and were poured in mid-November.• There was cold weather at negative thirty to forty degrees Celsius in the days leading up to the incident.• With the low temperatures, the generator with the heater was being used to prevent damage to the foundation from frost heaving which is upward swelling of soil during frost conditions.• It was a two-person job to get the generator into the basement as it was quite heavy and awkward. It was moved into the basement the evening of Dec 23, 2021.• The generator was placed in the basement to avoid theft and to keep it quieter for neighbors.• The generator ran well even in colder conditions, with a typical two pull start up.• The configuration of a gasoline generator in an enclosed space was not a configuration the co-worker had seen implemented in the time working with the company. They typically used generators outside as they were doing siding.• The generator was first started up in the basement on the morning of Dec 24th, 2021, and ran throughout the day while they installed plywood sub floor, window boarding and tarps.• The basement was left with an estimated 90% enclosure as the joist spaces were open to the outside at that time.• The co-worker did not have a headache or notice any smells or visible smoke in the basement, even with a work light, when they were shoveling snow from the entrance opening at the end of the day. They fueled the generator and left the site Dec 24th, 2021, around 5:30-6:00pm.• The co-worker stated that when leaving the site Dec 24, 2021, insulation was not installed in the joist spaces (window bucks) open to the exterior. The co-worker was not scheduled to return until Jan 4th, 2022.• The co-worker, upon returning after the incident, stated that the window bucks were filled with insulation.

Incident Summary #II-1309931-2021 (#25658) (FINAL)

Family member

- The worker who perished likely arrived on the site between 7:00-7:20am on Dec 26, 2021. The worker was there to refill the generator and fill any openings with insulation if needed.
- After the worker didn't answer the phone at 10am, they went to site and found the worker's truck still running on the street. The worker was found unresponsive inside the basement at approximately 10:45am.
- The family member exited the basement space to call 911. They mentioned they were familiar with toxic gas exposure from previous work experience.
- The gas can was found with the nozzle installed and placed upright on the ground in the basement. The generator had about a half tank indicated on the fill gauge. They did not turn off the generator and could not recall if it was running.
- There were tarps up in certain locations around the walls and at the openings where the joists extended past the walls of the basement.
- The family member did not note any visible smoke or smells in the basement.
- No other sources of carbon monoxide were identified in the basement.
- The family member stated feeling dizzy upon exiting the basement space.

Fire department statement

- Fire fighters attended the incident site around 11 am on Dec 26, 2021, and the four gas detector indicated a CO overlimit alarm outside near the entrance and within the basement. This indicated the sensor was over range and the unit had reached and likely gone over the 1000 PPM range for CO.
- The worker was found unresponsive near the generator.
- The gas tank cap was found set on the generator with the gas can nozzle readied for the gas can.
- The fire captain stated that it appeared the worker was refilling the generator with gasoline and had been quickly overcome by the carbon monoxide.
- The fire captain stated that based on the workers location and position, it appeared the worker appeared to have collapsed from the carbon monoxide and was not able to attempt to leave the space.
- The generator was not running when the fire fighters attended the site.
- The Honeywell BW Max XTII gas detector that was used by the firefighters and indicated CO overlimit has a range of 0-1000 PPM for carbon monoxide.

Owner Statements

- The site owner stated the basement space is approximately 1300 square feet with an 8 to 8-1/2-foot ceiling height.

Conclusions

The site conditions, configurations and events for this incident are consistent with rapid onset carbon monoxide poisoning where an occupant is exposed to high concentrations of carbon monoxide over a short period of time. In such an incident, an occupant may have no opportunity to recognize the symptoms and exit the space and rather becomes incapacitated leading to continued exposure to the lethal effects of carbon monoxide

Causes and
contributing factors

Incident Summary #II-1309931-2021 (#25658) (FINAL)

Cause

The use of a fuel burning portable electric generator in the enclosed unventilated basement space resulted in an accumulation of hazardous concentrations of carbon monoxide.

Note: Technical Safety BC's scope of investigation and findings are limited to the likelihood of the equipment having produced a carbon monoxide environment. Cause of death is determined by the BC Coroners Service.



Image 1 – Insulated concrete block formed basement walls with plywood subfloor. Single point of entrance with orange tarp.



Image 2 – Basement of house under construction. Generator (bottom) with fuel cap off and nozzle readied on gas can.



Image 3 – Electric gasoline fueled generator



Image 4 – Generator top view including warning labels



Image 5 – Closeup of generator warning label

⚠ WARNING

Exhaust contains poisonous carbon monoxide gas that can build up to dangerous levels in closed areas. Breathing carbon monoxide can cause unconsciousness or death.

Never run the generator in a closed, or even partly closed area where people may be present.

Carbon Monoxide Hazards

A generator's exhaust contains toxic carbon monoxide, which you cannot see or smell. Breathing carbon monoxide can KILL YOU IN MINUTES. To avoid carbon monoxide poisoning, follow these instructions when operating a generator:

- Only run a generator OUTSIDE, far away from windows, doors, and vents.
- Never operate a generator inside a house, garage, basement, crawl space, or any enclosed or partially enclosed space.
- Never operate a generator near open doors or windows.
- Get fresh air and seek medical attention immediately if you suspect you have inhaled carbon monoxide.

Early symptoms of carbon monoxide exposure include headache, fatigue, shortness of breath, nausea, and dizziness. Continued exposure to carbon monoxide can cause loss of muscular coordination, loss of consciousness, and then death.

To alert you to potentially dangerous levels of carbon monoxide coming from a generator operating outside or from other sources, install battery operated carbon monoxide alarms or plug-in carbon monoxide alarms with battery back-up on every level of the home and outside sleeping areas, according to the manufacturer's instructions.

Image 6 – Warning from generator manual

Image 7 – Hazard information from generator manual

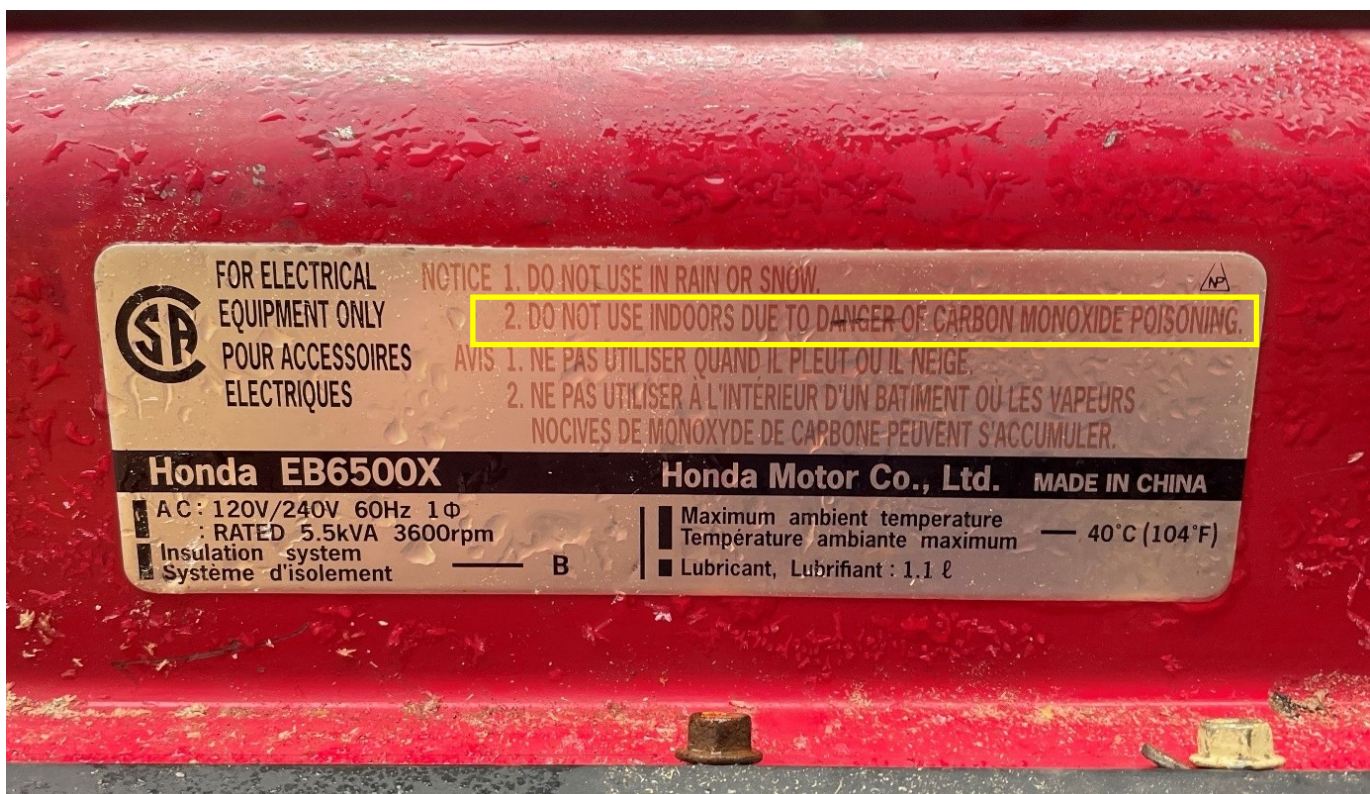


Image 8 – Generator carbon monoxide notice



Image 9 – Electric heater with fan.

Properties of Carbon Monoxide

<i>Colourless</i>	Cannot be seen.
<i>Tasteless</i>	Cannot be detected through the sense of taste.
<i>Odourless</i>	Cannot be detected by sense of smell, However, CO can also be accompanied by aldehydes. Aldehydes' odour can somewhat resemble vinegar, which can be detected by the sense of smell, and may also result in a metallic taste in the mouth.
<i>Non-irritating</i>	Carbon Monoxide will not cause irritation. However, aldehydes usually present with higher levels of CO will irritate the eyes, nose, and mucous membranes.
<i>Specific gravity</i>	Slightly lighter than air (Sg 0.975). It may, but not always collect near the ceiling, and mixes freely with air.
<i>Flammable (explosive) limits</i>	CO is flammable between concentrations of 12.5% to 74% when mixed with air. Its ignition temperature is 609°C (1128°F).
<i>Toxic</i>	Can cause death if enough is absorbed into the bloodstream.

Chart 1 – Properties of carbon monoxide from Technical Safety BC's [Carbon Monoxide Handbook](#)

Concentrations (*ppm) Observations and Health Effects

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

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

Chart 2 – Carbon monoxide concentrations and health effects from
Technical Safety BC's [Carbon Monoxide Handbook](#)

Acute exposure guideline levels for carbon monoxide

Classification (description)	Duration				
	10 min	30 min	1 hour	4 hours	8 hours
Disabling Irreversible or other serious, long-lasting adverse health effects, or an impaired ability to escape.	420 ppm*	150 ppm	83 ppm	33 ppm	27 ppm
Lethal Life-threatening health effects or death)	1700 ppm	600 ppm	330 ppm	150 ppm	130 ppm

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

Table 1 – Acute exposure guideline levels for carbon monoxide showing health effects based on carbon monoxide concentration levels and exposure duration. Adapted from National Research Council (US) Committee on Acute Exposure Guideline Levels (AEGL)¹

¹ National Research Council (US) Committee on Acute Exposure Guideline Levels. Acute Exposure Guideline Levels for Selected Airborne Chemicals: Volume 8. Washington (DC): National Academies Press (US); 2010. 2, Carbon Monoxide Acute Exposure Guideline Levels. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK220007/> (Accessed August 11, 2020.)