

# HYDROGEN FUEL CELL GENSET SAFETY AND INSTALL

*DISCLAIMER: This Hydrogen Fuel Cell Genset Safety and Installation Bulletin is a general guideline. The Hydrogen Fuel Cell Genset equipment manufacturer and local regulations should be consulted for complete requirements.*

## 1. SCOPE

This Installation Bulletin covers outdoor use of mobile/transportable Hydrogen Fuel Cell Generators in British Columbia. The 2022 revision of the Canadian Hydrogen Installation Code (CAN/BNQ 1784-000) covers portable equipment in Chapter 10; however, this content does not cover the equipment of this document.<sup>1</sup> CAN/BNQ 1784-000 is applied where applicable.

## 2. REGULATORY COMPLIANCE

Mobile/transportable Hydrogen Fuel Cell Generators shall have:

- Electrical certification to a recognized standard or approval mark acceptable to Technical Safety BC (TSBC), the regulatory authority in British Columbia.
- Gas appliance product approval or product certification acceptable to TSBC. Note that product certification shall be performed by a 3<sup>rd</sup> party agency accredited by the Standards Council of Canada.
- Gas Operating Permit from TSBC to operate the Hydrogen Fuel Cell Genset.
- Additional municipal approvals or permits may be required for generators. Owners/Operators shall verify with municipal authorities to ensure Hydrogen Fuel Cell Generator operation is in accordance with local bylaws and municipal permit requirements.

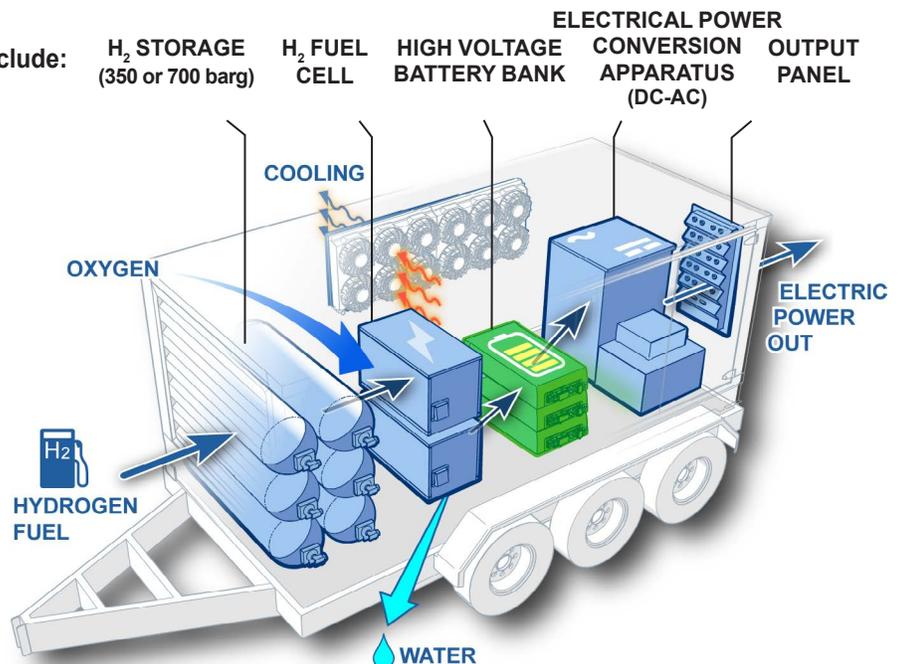
## 3. HYDROGEN FUEL CELL GENSET BASICS

Hydrogen Fuel Cell Gensets are typically composed of the same components as a Fuel Cell Electric Vehicle (FCEV). Hydrogen Fuel Cell Gensets use a Hydrogen Fuel Cell to combine stored hydrogen gas and oxygen present in the air to produce electricity, with water as the only byproduct.

**Components on a Hydrogen Fuel Cell Genset include:**

H <sub>2</sub> STORAGE (350 or 700 barg)	H <sub>2</sub> FUEL CELL	HIGH VOLTAGE BATTERY BANK	CONVERSION APPARATUS (DC-AC)	ELECTRICAL POWER OUTPUT PANEL
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The Hydrogen Fuel Cell Genset provides reliable, clean power to end users via its onboard battery system. When the battery needs recharging, stored hydrogen is processed in the Hydrogen Fuel Cell, where it is combined with oxygen from the air and transformed into water, heat, and electricity. The electricity both replenishes the battery and powers connected equipment, ensuring continuous, zero-emission operation.



<sup>1</sup> Source: CAN/BNQ 1784-000 2022 Canadian Hydrogen Installation Code, Clause 10.1 Note.

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## 4. SAFETY PRECAUTIONS

Safety precautions addressing Hydrogen Fuel Cell Genset hazards shall be in accordance with those defined by the equipment manufacturer and in accordance with all AHJ requirements. It is important that the operator is aware of these hazards and that the generator is well maintained.



### GENERAL HYDROGEN HAZARDS

### MITIGATION STRATEGIES

**Hydrogen has a relatively wide flammability range (4% to 75% in air) and low ignition energy.**

Hydrogen Fuel Cell Gensets shall be parked in a location that provides adequate ventilation to keep air/hydrogen mixture from any small hydrogen leaks outside of the flammability range. Care must be taken to ensure that all the Hydrogen Fuel Cell Genset inlet and exhaust vents have unobstructed flow.

The hydrogen fuel system is tested for leaks in the factory to strict standards. Small fuel leaks may develop over time. Hydrogen Fuel Cell Gensets are designed to prevent hazardous conditions from occurring within the unit if maintained and used per the manufacturer's instructions.

**Hydrogen is odorless making olfactory detection difficult.**

Hydrogen Fuel Cell Gensets shall include hydrogen gas detectors. Handheld hydrogen gas detectors may also be considered for personnel performing maintenance.

**Hydrogen burns with a pale blue or invisible flame, making visual detection difficult.**

A spark of static energy or a surface temperature above autoignition is required to ignite fuel to burn. Hydrogen Fuel Cell Gensets shall utilize electrical wiring and equipment suited to the hazardous rating of the area in which it is installed. Furthermore, Hydrogen Fuel Cell Gensets shall be grounded and located away from ignition sources. See manufacturers' documentation for minimum distances to ignition sources.

**Hydrogen is lighter than air and rises rapidly at approximately 72 km/h or 20 m/s. This assists in dispersion outdoors. However, hydrogen can still accumulate under ceilings, overhangs or in confined spaces indoors.**

Hydrogen Fuel Cell Genset parking shall consider the proximity of structures which may accumulate rising hydrogen, such as canopies or openings in buildings. Indoor operation and storage is not permitted.



**Hydrogen Fuel Cell Gensets typically include a battery bank and may include voltage in excess of 600 VDC between conductors or between conductor and ground.**

Electrical Hazards shall be indicated on equipment with appropriate signage/decals and shall only be accessed by qualified personnel.

**Hydrogen Fuel Cell Genset battery banks may consist of modern battery chemistries with high charge density, which can pose a risk of thermal runaway (an uncontrolled exothermic reaction). Some modern battery chemistries include<sup>2</sup>:**

Consult equipment documentation and/or manufacturer for system safety pertaining to thermal runaway and other modern battery hazards.

Hydrogen Fuel Cell Gensets shall be sited outdoors with minimum distances from flammable liquids/gases and occupied spaces as specified in equipment documentation.

- **Lithium Iron Phosphate (LiFePO<sub>4</sub>, LFP) -**  
Safer than NMC/NCA due to its higher trigger point (~270 °C); LFP can still experience thermal runaway.
- **Nickel Manganese Cobalt (NMC) -**  
Thermal runaway trigger temperature of ~210 °C.
- **Nickel Cobalt Aluminum Oxide (NCA) -**  
Thermal runaway trigger temperature of ~150 °C.

Transportation of Dangerous Goods (TDG) decals indicating battery presence shall be placed on clearly visible areas of the outside of the Hydrogen Fuel Cell Genset to alert first-responders.

<sup>2</sup> <https://www.recurrentauto.com/research/lfp-battery-in-your-next-ev-tesla-and-others-say-yes#:~:text=Lithium%20ion%20battery%20fires%20are,and%20150%20C%20for%20NCA>.

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## 5. INSTALLATION AND OPERATION

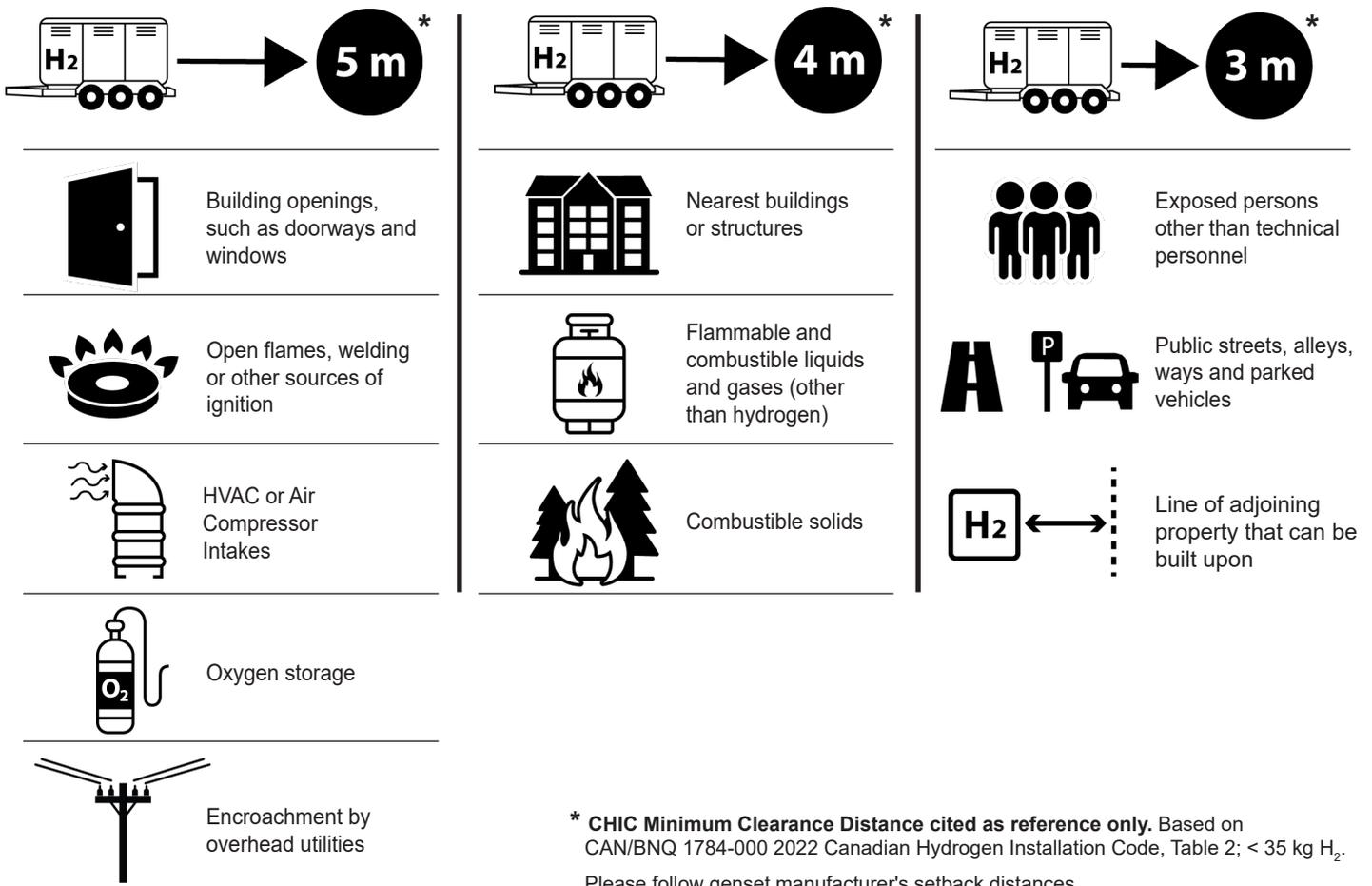
### 5.1 FUEL QUALITY

- Fuel cell-based hydrogen generators typically require specified quality of hydrogen fuel. Standards such as SAE J2719 (Hydrogen Fuel Quality for Fuel Cell Vehicles), or ISO/DIS 14678-2 (Hydrogen Fuel – Product Specification) may be used by Hydrogen Fuel Cell Genset manufacturers to define hydrogen fuel quality requirements. Refer to Hydrogen Fuel Cell Genset manufacturer for specific hydrogen fuel quality requirements.

### 5.2 HYDROGEN FUEL CELL GENSET SITING

- Hydrogen Fuel Cell Genset siting shall be defined by equipment manufacturers to ensure that no sources of ignition present a combustion explosion hazard. Setbacks shall be calculated by the manufacturer using methodology defined in IEC 60079-10-1 and sound engineering practice.
- Minimum clearance distances shall be in accordance with those defined by the Hydrogen Fuel Cell Genset manufacturer. If minimum distances are not provided, consult the Canadian Hydrogen Installation Code (CHIC), CAN/BNQ 1784-000, Table 2 as a reference. Note that in British Columbia, the CHIC is in force under the jurisdiction of Technical Safety BC (TSBC). **However, the CHIC does not specifically address these types of mobile/transportable applications such as mobile Hydrogen Fuel Cell Gensets.**
- Minimum clearance cited by equipment manufacturer shall include distances from the following items:

#### MINIMUM CLEARANCE DISTANCE



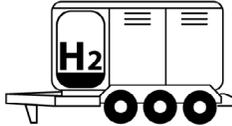
\* CHIC Minimum Clearance Distance cited as reference only. Based on CAN/BNQ 1784-000 2022 Canadian Hydrogen Installation Code, Table 2; < 35 kg H<sub>2</sub>. Please follow genset manufacturer's setback distances.

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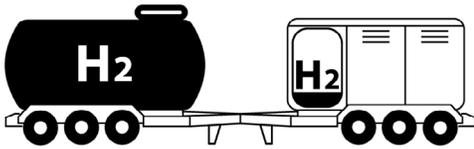
## 5.3 HYDROGEN REFUELING REQUIREMENTS

Refueling of Hydrogen Fuel Cell Gensets may occur at vehicular hydrogen dispensing stations or on-site where used. In addition, Hydrogen Fuel Cell Gensets may store fuel in various configurations, including, but not limited to:

### H<sub>2</sub> STORAGE



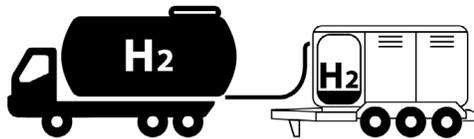
**1. HYDROGEN FUEL CELL GENSETS WITH ONBOARD HYDROGEN STORAGE CYLINDER(S);** these cylinders are typically filled with pressures of 350 barg (H35) or 700 barg (H70). Refueling ports for these are specific to the fill pressure of the system to avoid accidental overpressure.



**2. HYDROGEN FUEL CELL GENSETS WITH SEPARATE HYDROGEN STORAGE;** this may take the form of a hydrogen bulk pack that is connected to the Hydrogen Fuel Cell Genset with a hydrogen supply hose. When the hydrogen bulk pack is depleted, it may be disconnected and replaced with a replenished supply.

In either of these cases, the following must be considered by the Hydrogen Fuel Cell Genset operator when refueling hydrogen storage:

### H<sub>2</sub> REFUELING



**1. ON-SITE REFUELING** to be performed by a gas refueling service provider approved by TSBC; this is consistent with similar requirements for on-site refueling of gas storage for natural gas or propane.

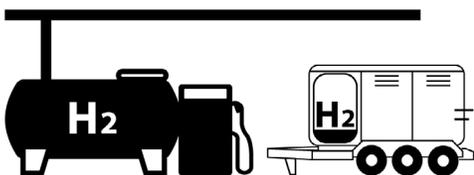
On-site refueling to be performed at least **5 m\*** from:

- the nearest building or structure
- flammable and combustible liquids (above ground)
- oxygen storage
- open flames, welding, or other sources of ignition
- adjoining properties
- overhead power lines

On-site refueling to be performed at least **4 m\*** from:

- flammable and combustible liquids (below ground)
- flammable gas storage (other than hydrogen)
- combustible solids (lumber, paper, coal)
- public streets and parked vehicles

\* These setbacks are based on setback requirements for gaseous hydrogen storage systems specified in CHIC, Table 2. Consult the Hydrogen Fuel Cell Genset operation manual for equipment refueling requirements and procedures.



### **2. PUBLIC HYDROGEN DISPENSING STATIONS:**

If equipped with the appropriate equipment, Hydrogen Fuel Cell Gensets may be refueled at public hydrogen dispensing stations. Consult the Hydrogen Fuel Cell Genset operation manual for equipment refueling requirements and procedures.

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## 6. EMERGENCY RESPONSE

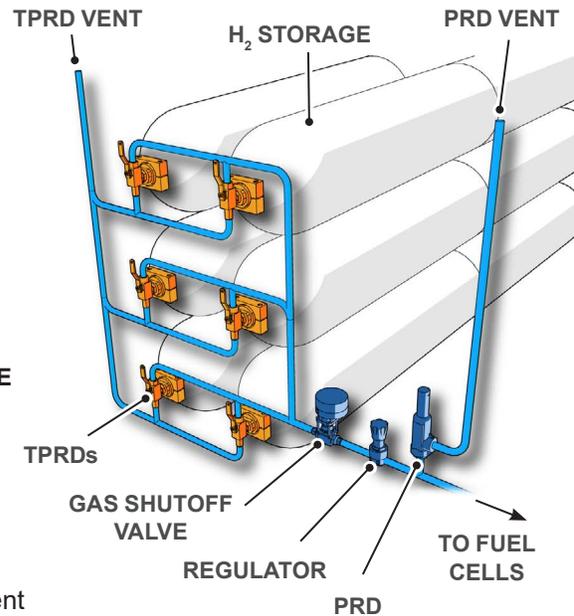
The emergency response to a Hydrogen Fuel Cell Genset is similar to that of a hydrogen FCEV. The total hydrogen stored for Hydrogen Fuel Cell Gensets is comparable to heavy-duty FCEVs, although this depends on the Hydrogen Fuel Cell Genset.

High-pressure hydrogen is only stored inside the storage cylinders and is isolated by a fail-safe **GAS SHUTOFF VALVE**. Downstream hydrogen gas pressure is limited by the regulators and **PRESSURE RELIEF DEVICES (PRD)**. The exhaust from PRDs is directed to vents that exit through the top of the Hydrogen Fuel Cell Genset. Each storage cylinder has a **THERMAL PRESSURE RELIEF DEVICE (TPRD)**, which is activated with heat. The exit of the TPRD is located away from personnel and is generally vented through the top of the Hydrogen Fuel Cell Genset.

Over and above the standard first responder protocol, hydrogen-specific first-responder considerations include:

- Arriving upwind of the incident scene and ensuring first-responder equipment doesn't cross a flammable gas cloud
- Stopping first-responder equipment between 50 and 100 metres from the incident
- Determining incident details:
  - Distance between the fire/incident and the Hydrogen Fuel Cell Genset
  - Is hydrogen leaking, as indicated by auditory indicators (high-pitched hissing sound)?
  - Are generator status lights indicating an alarm?
  - Have TPRDs or PRDs been activated, as indicated by gas exiting the vent stack(s)?
- Determine exposure protection, including:
  - Checking first-responders' hydrogen sensors
  - Checking hydrogen cylinder temperatures as well as the presence of any hydrogen flames with thermal imaging camera
  - Activating the emergency shutdown devices (E-Stops) on the Hydrogen Fuel Cell Genset
- Due to the limited amount of hydrogen stored on the unit, it is generally advised to allow it to vent out and/or burn. In case of a fire, individual cylinder TPRDs will trigger venting out of the cylinder content

For a more comprehensive review of hydrogen first-responder considerations, see the HTEC Safety Hub resources listed in the Resources section below.



## 7. RESOURCES FOR FURTHER INFORMATION

Further information on hydrogen and Hydrogen Fuel Cells is available in the listed resources:

RESOURCE	CONTACT
HTEC Safety Hub	<a href="https://www.htec.ca/safety-hub/">https://www.htec.ca/safety-hub/</a>
Technical Safety British Columbia (TSBC)	<a href="https://www.technicalsaftybc.ca/technologies/gas">https://www.technicalsaftybc.ca/technologies/gas</a>
H <sub>2</sub> Tools	<a href="https://h2tools.org/">https://h2tools.org/</a>
Center for Hydrogen Safety	<a href="https://www.aiche.org/chs">https://www.aiche.org/chs</a>
Canadian Hydrogen Association	<a href="https://canadah2.ca/education-centre/">https://canadah2.ca/education-centre/</a>
Hydrogen British Columbia	<a href="https://canadah2bc.ca/">https://canadah2bc.ca/</a>