



Inspection Bulletin

North American Standard Inspection Program

2024-02 – Hydrogen Fuel Cell Commercial Motor Vehicle Inspections

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Summary

This bulletin will educate inspectors about the hazards of hydrogen fuel cell electric vehicles (HFCEV).

Background

Hydrogen fuel cell electric powered vehicles are currently being deployed throughout North America. This technology is considered the most viable for the commercial transportation industry. These vehicles use hydrogen conversion technology to convert hydrogen to electricity which ultimately powers the e-axle and propels the vehicle.

This inspection bulletin highlights the key vehicle warnings and components that inspectors should be aware of while conducting inspections.

Inspection Location

All inspections of these types of vehicles must occur outside in the open air. The vehicles must **NOT** be inspected or stored indoors unless the facility has been designed to accommodate HFCEVs.

Hydrogen Safety

Hydrogen Characteristics

- Hydrogen gas is colorless, odorless and tasteless.
- Hydrogen gas is highly flammable, may form explosive mixture with air and ignites easily.
- The flammability range of hydrogen is 4 to 74% (40,000 to 740,000 ppm) in air. If available, use a properly calibrated gas detection device to check hydrogen concentration near the vehicle.
- Hydrogen gas can accumulate in confined spaces, creating an asphyxiation hazard.
- Hydrogen is lighter than air and can diffuse rapidly; therefore, a small leak will quickly dissipate to a low concentration which cannot ignite.
- Smoking, open flames and spark-producing activities are not permitted near hydrogen systems.
- If available, always wear recommended personal protective equipment (PPE) when handling, transporting and working around hydrogen systems.

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First Responder Pamphlet

Although not required by the regulations, a first responder pamphlet from the manufacturer should always be inside the vehicle. If needed, check with the driver to determine the location of this document.

Vehicle Safety Features

The following safety features should be present when inspecting hydrogen fuel cell electric vehicles.

Low Voltage

Master Disconnect Switches

Master disconnect switches are located under the vehicle's hood, behind the driver's steps (accessible via trap door) or in cab of the vehicle, depending on the model. The directional position of the switch will indicate the status of the system.

The 12/24 volts direct current (VDC) disconnect switches stop the 12/24 VDC distribution to the vehicle, preventing the high voltage from energizing and allowing low voltage for vehicle inspection.

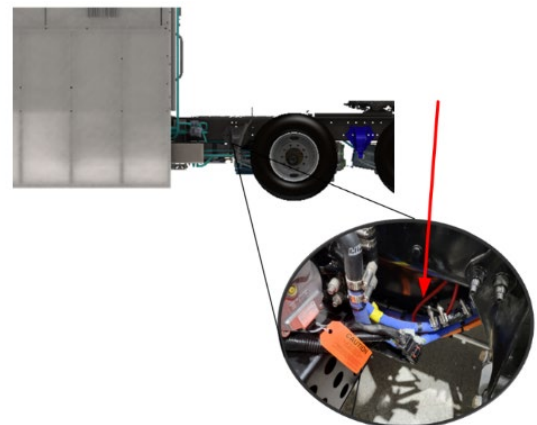


High Voltage

Cut Loop

The cut loop is usually located in front of the first rear wheels of the vehicle on both sides but may differ depending on the model. Refer to the vehicle's documentation for the cut loop's location. When cut, the cut loop disables the complete vehicle electric system (low and high voltage).

Note: Using the high voltage cut loop safety device will immediately cut power to the vehicle, which may damage system components. Cut loops are to be used only in emergency situations. High voltage lines should never be cut by someone who has not received specific first responder training in this area.



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S-Box Manual Service Disconnect

The S-box manual service disconnect (MSD) is found in the S-box and can be removed to disconnect high voltage from the battery to the rest of the vehicle.

Removing the S-box MSD does not cut the power to some areas of vehicle, so caution is still needed if this has been disconnected. The power is still live between batteries and the S-box if the battery MSDs are not removed.



Battery Manual Service Disconnect

The battery MSD is located at each of the batteries. The MSD can be removed to disconnect the element from the vehicle's electrical circuit. Battery MSDs are bolted in place and disconnect should only be attempted by trained individuals.



Torque Removal Button

The emergency push button, located on the driver dashboard, will disable the hydrogen and propulsion systems. The battery will still be active to maintain power steering and the air braking system.



Isolation Monitoring

The isolation monitoring circuit is constantly measuring the isolation resistance in the high voltage electric circuit. If a loss of isolation is detected, the system will react to secure the vehicle.

This is typically a light on the dash which will be illuminated, indicating to an inspector that there is some fault; an inspection is **NOT** recommended on this vehicle. This condition will require maintenance personnel to evaluate the vehicle and reset the telltale indicator.

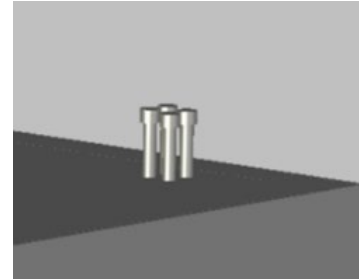


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Hydrogen

Hydrogen Venting Pipes

The hydrogen venting pipes are located above the hydrogen tanks and fuel cells and allow hydrogen dispersal in the event of a pressure release or a thermal pressure relief device (TPRD) release. These pipes have a cap that allows venting and must never be obstructed.



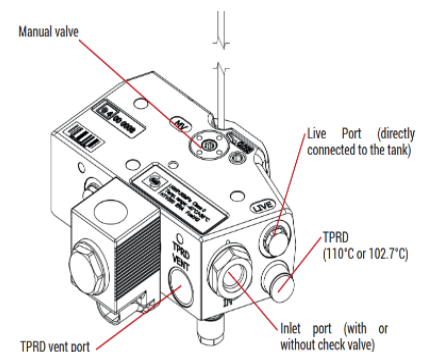
Manual Shut-off Valve

The manual shut-off valve is located in the hydrogen storage area and stops the hydrogen supply from the tanks to the fuel cells. During an incident, if safe to do so, the valve should be closed. Refer to the vehicle's documentation for the valve's location.



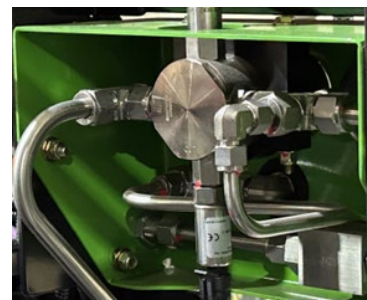
Thermal Pressure Relief Device

The thermal pressure relief device is located at the hydrogen tanks and is a glass component that will break, releasing hydrogen through the hydrogen venting pipes, if high temperatures are reached around the hydrogen tanks.



Pressure Relief Valve

The pressure relief valve (PRV) is located near the hydrogen storage tanks. If the hydrogen circuit becomes over-pressurized, the PRV will safely relieve the excessive pressure through the hydrogen venting pipes at the top of the hydrogen storage tank area.



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Hydrogen Sensors

Hydrogen sensors are located around the tank and fuel cell areas. The hydrogen sensors detect the presence of hydrogen gas. They are utilized in the hydrogen storage tank area to detect if a leak has occurred in the system. If a hydrogen leak occurs and is detected, the system will have a safety shutdown. This should be indicated by a light on the dashboard or other location.



Stored Energy/Liquids/Gases/Solids

Warning labels can be found at different locations on the vehicle, indicating the associated hazards and appropriate safety measures.



High Voltage (618 V)



Corrosives



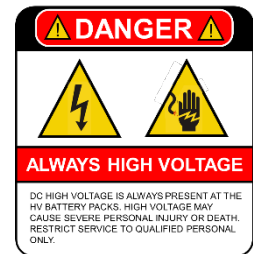
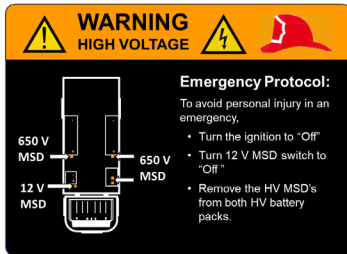
Flammable



Health Hazards

Safety Labels

Electric vehicles will be marked with high voltage warning labels at the required locations, such as junction boxes, batteries, air compressor, etc. Below are some examples.

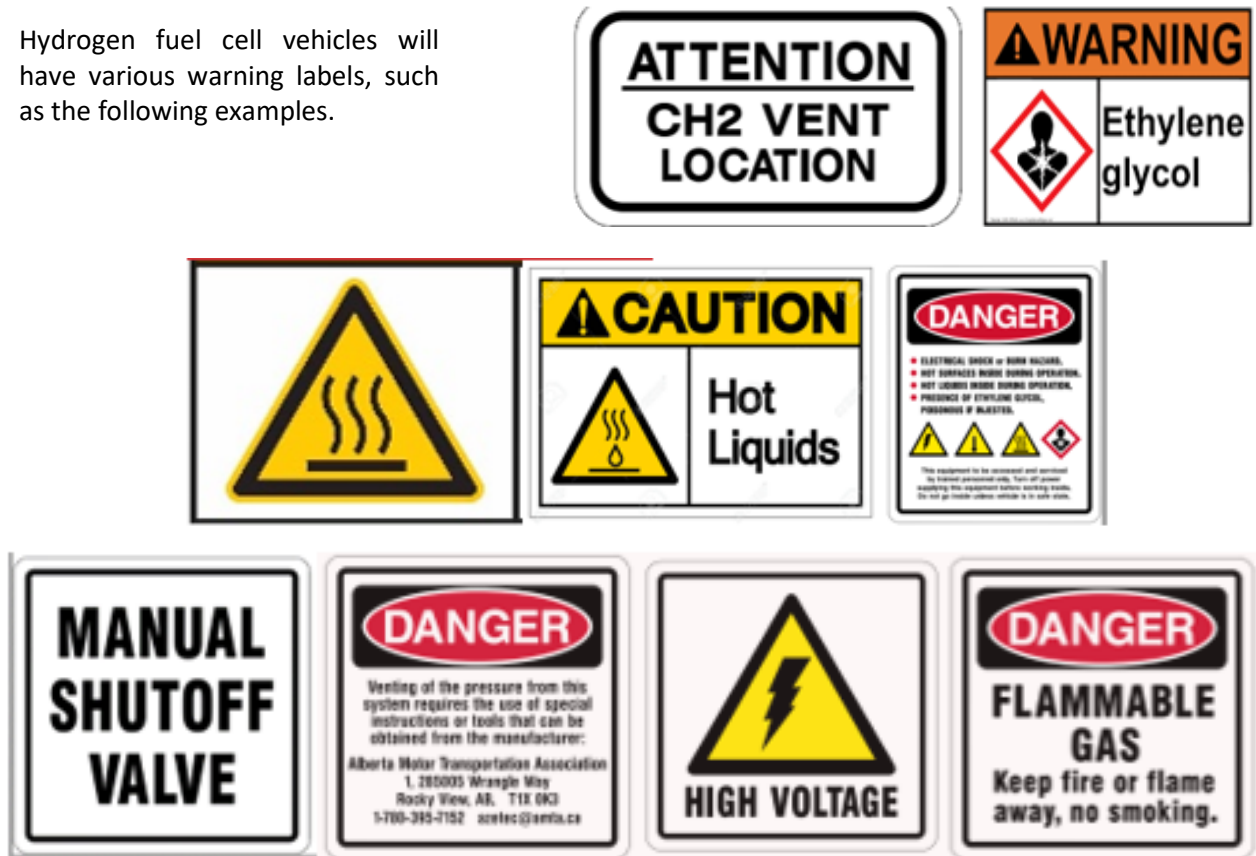


Hydrogen storage tank areas should be marked using the following labels, which identify the hydrogen content.



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Hydrogen fuel cell vehicles will have various warning labels, such as the following examples.



Tow Truck Operations

Each model of hydrogen fuel cell electric vehicle has very specific towing procedures. **DO NOT** tow unless you refer to each model's manufacturer requirements, which should be located inside the vehicle. If the instructions are not available, check with the driver or manufacturer before towing.

Towing/Transportation/Storage

Refer to the owner's manual for each specific model for proper procedures when interacting with the vehicle. Towing a fuel cell electric vehicle can be very dangerous by generating electricity back into the system. It is recommended that the manufacturer be contacted for specific towing instructions.

Disable Direct Hazards Safety Procedure

Assume all high voltage components are always energized. Do not cut any high voltage components, including high voltage orange cables, during an emergency. The cut loop safety device must be cut by trained personnel.

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Normal operations truck shutdown method:










1. Unplug the charger cable or remove power from the charger.
2. Remove the key from the ignition or power off the vehicle using the start stop button.
3. Engage parking brakes.
4. Turn 12/24-volt disconnect counterclockwise to the OFF position.

Note: Cables between the high voltage battery and the S-box remain energized following 12/48-volt disconnect.

Fire

Always wear full fire fighter PPE (turnout gear), including a positive pressure self-contained breathing apparatus, when treating a fire. Treat fires involving charging stations as energized fires until power to the charger can be shut down.

Specialized Hydrogen Fuel Cell Vehicle Markings

| | |
|---|---|
|  Use Water to control Li-ion Fires |  Do Not Use Wet Foam |
|  Do not douse Hydrogen tanks with water |  Flammable Components |
|  Explosion Hazard: <ul style="list-style-type: none"> • Explosive gas could accumulate. • Move truck outside building after extinguishing fire |  Corrosives: <ul style="list-style-type: none"> • Causes skin burns and eye damage |
|  High Voltage (650 V): <ul style="list-style-type: none"> • CAT III (1000 V) rated gloves required for exposed HV parts |  Check Li-ion Battery Pack for Fires with Thermal Infrared Camera (TIC or IR Gun) |
|  Hazardous to Human Health: <ul style="list-style-type: none"> • May cause an allergic skin reaction • Do not breathe dust, fumes, gas, mist, vapors, or spray. | |

Water Submersion

If high voltage component damage exists (hissing, crackling, bubbles, exposed cables, etc.), call the vehicle's manufacturer for guidance. If no high voltage component damage exists, remove the truck from the water, drain the water and follow disable direct hazards. Do not attempt to drive the vehicle.



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Inspection Guidance

Only a person who is trained in the operation and potential hazards of HFCEV systems can safely conduct in-depth inspections. CVSA inspectors should be familiar with the safety features outlined in this bulletin but should only conduct visual inspections of hydrogen fuel cell vehicles. Inspectors should also be familiar with inspections of electric drive vehicles and review CVSA Inspection Bulletin 2015-06 Electric-Drive Commercial Motor Vehicle Inspections for additional information and inspection. Always wear the recommended personal protective equipment issued by your department (gloves, boots, etc.).

When visually inspecting the hydrogen fuel cell vehicle, ensure that:

- There are no visual or audible indicators of leaking hydrogen
- Fuel lines and connections are secure and properly protected from chafing
- There are no coolant leaks from the hydrogen fuel cell cooling system
- Electrical connectors are not damaged or not secure
- Wiring is not exposed, corroded, damaged, loose or improperly protected against chafing
- Other equipment is not damaged or loose, the cover is not bulged, fluid is not leaking, and there is no indication of burning, arcing or overheating

Note: Nikola commercial motor vehicles have an added safety feature. Drivers must have a PIN number to start the vehicle. The fuel cell electric vehicle master disconnect switch should not be turned off for an inspection, but the vehicle cannot be started without the driver PIN being entered.