Module 2
Responding to an Incident

HTEC
FUELING THE DRIVE TO HYDROGEN
www.htec.ca

Disclaimer

Thank you for you interest in hydrogen! Hydrogen is a key driver in Canada's transition to clean energy. Like any fuel, it must be handled responsibly, with a strong understanding of its properties and well-established safety protocols. At HTEC, we prioritize safety at every level—from infrastructure design to fuel storage and refueling operations—ensuring hydrogen is integrated safely and effectively into our energy system.

Disclaimer

This module is intended as a compendium of information to support training and awareness for first responders. The guidance provided should be interpreted in the context of applicable national, regional, and local regulations, protocols, and operational procedures.

This document is for general informational purposes only and does not replace official emergency response protocols or professional judgment. It reflects current knowledge and best practices at the time of publication and may be updated as new information becomes available.

While the content has been developed with care and input from industry professionals, HTEC accepts no liability for how this information is used.

Users are encouraged to provide feedback and consult with their respective agencies before applying any of the guidance in practice.

If you have comments or questions, please contact: **info@htec.ca**

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CONTENTS

Hydrogen Emergency Response
RESOURCES AND REFERENCE MATERIALS

There are several sources that were accessed to create this module. Links to these sources will be provided for further research and understanding.

In addition, we **HIGHLY RECOMMEND** that you visit:

CENTER FOR Hydrogen SAFETY

Weblink

Offers a free "CHS First Responder Micro Training Learning Plan," which helps equip first responders with technical knowledge to mitigate hydrogen-related risks.

European Train the Trainer Programme for Responders

Hy Responder

Fuel Cells and Hydrogen Joint Undertaking (FCH JU)
Grant Agreement Number 875089

Weblink

European Emergency Response Guide

European based leading hydrogen incident guide for trained responders, supporting decisions from first call to final inspection.

TRANSPORTATION

Light Duty FCEVs
Heavy Duty FCETs

Transportation

INTRO TO HYDROGEN FUEL CELL ELECTRIC VEHICLES (FCEVS)

SOURCE: AIChE Academy, https://youtu.be/aoH9xFCBxKk

Transportation
FCEV FIRE RESPONSE AND EXTRACTION

SOURCE: AIChE Academy, https://youtu.be/KQLaMcqP7vA

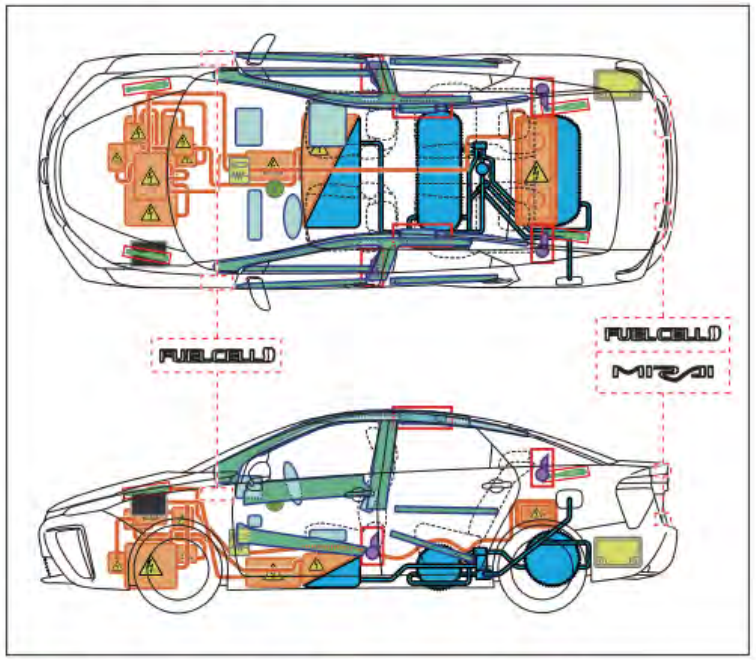
Transportation
RESPONSE GUIDES

H2tools keeps a page of current hydrogen light and heavy-duty hydrogen fuel cell vehicle models available in North America and links to applicable information pages.

Note: the H2 Tools website is currently missing some links to heavy duty truck models. It is expected that these models will be available on the H2 tools website soon.

In the following slides, links are provided to emergency response guides for vehicles commonly found on roads where HTEC operates.

Transportation
RESPONSE GUIDES – LIGHT DUTY FCEVs



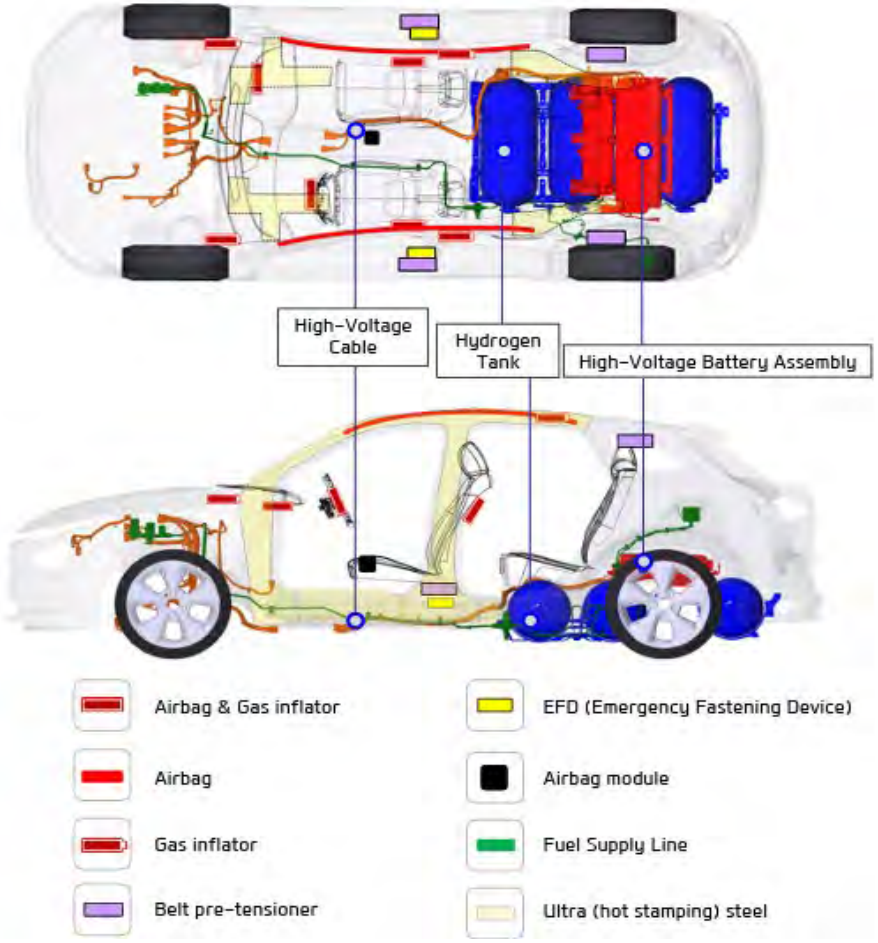
	IG/POWER SW		Fuse Box		12V Battery
	Airbag (incl. Inflator)		Inflator		High Voltage Battery
	High Voltage Components		Hydrogen Tank		Hydrogen Components
	Gas-filled Damper		Seat Belt Pretensioner (Gas Generator)		Structural Reinforcements
	Airbag Computer	—	—	—	—

[2015 Mirai ER Quick Guide]

[2020 Mirai ER Guide]

[Hyundai Nexo ER Guide]

Hyundai Nexo



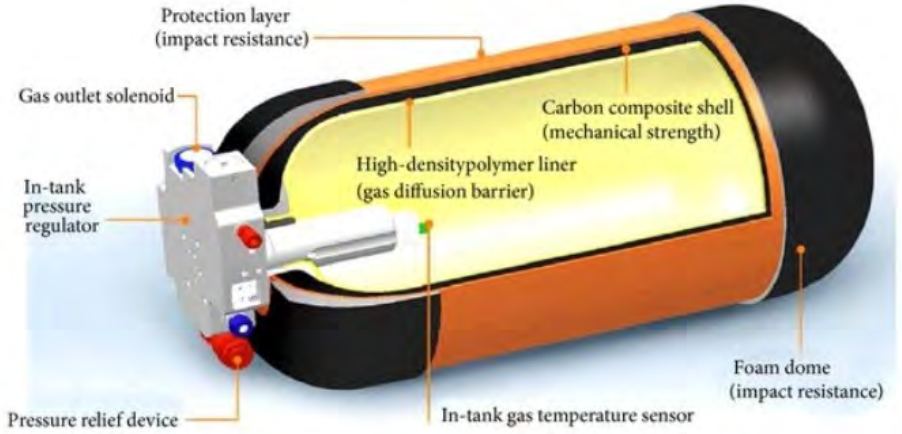
Transportation
H2 STORAGE ON LIGHT DUTY FCEVs

Light Duty Vehicles General Specifics

Tank Construction	Type IV
Tank Size (water volume)	~60 L
Max Pressure	70 Mpa (700 barg / 10,000 psig)
Number of tanks	2-4
Hydrogen stored on board	~4.5 kg

Key Facts

- In-Tank Pressure Regulator – High pressure hydrogen is only stored inside the tank. In-tank regulators limit the pressure down stream of the tank.
- TPRDs:
  - Activated with heat – 110°C (230°F).
  - Exit of TPRD located near the rear wheel well, pointing downwards.
  - Full pressure of tank vented through TPRD.
  - Each tank has its own TPRD



Type IV Tank used in FCEV vehicles

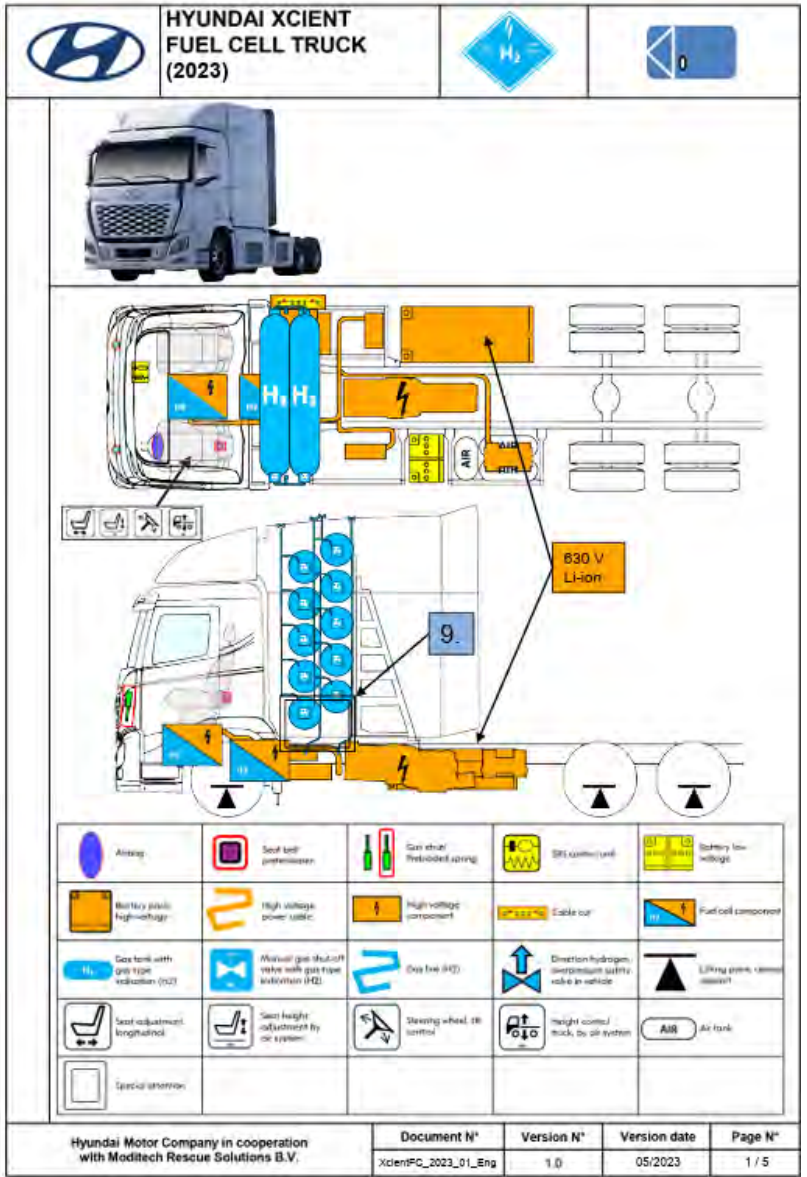
(a)

(b)

Hydrogen tank and TPRD venting direction:
(a) the installed TPRD near the hydrogen tank and
(b) the hydrogen tank position in the fuel cell electric vehicle (FCEV).

TRANSPORTATION – HEAVY DUTY (FCEVs)

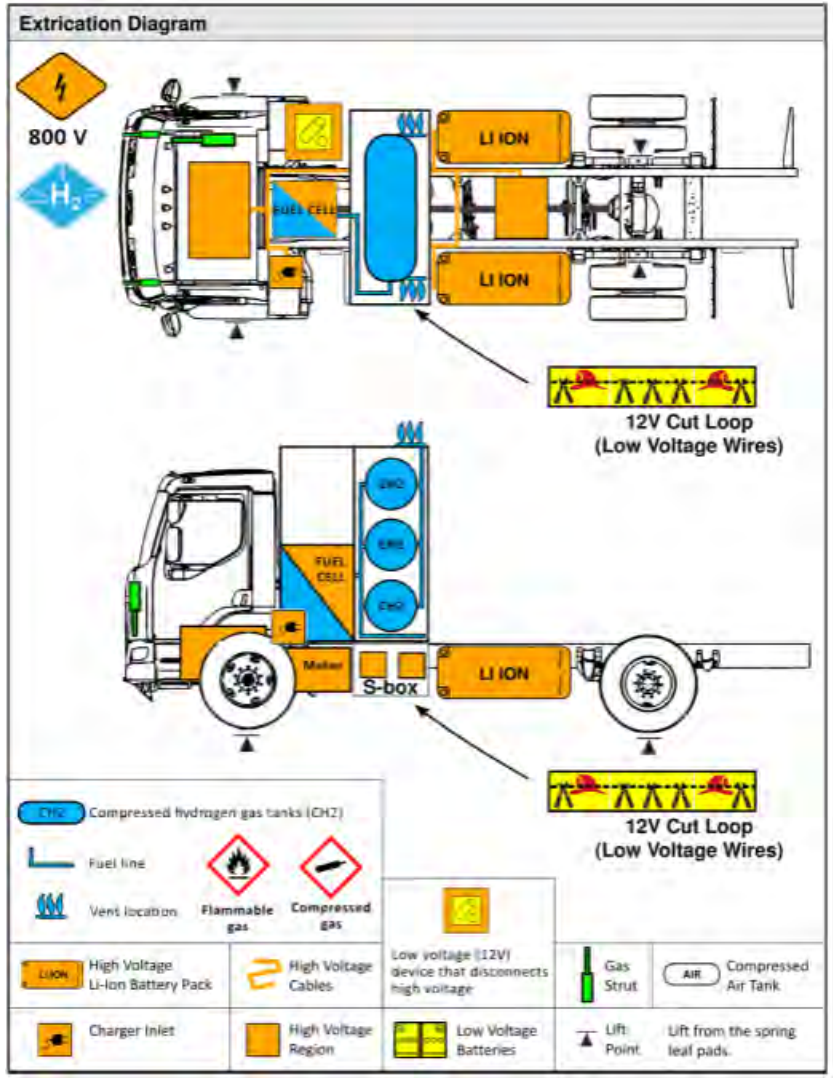
Transportation
RESPONSE GUIDES – HEAVY DUTY FCETs



[Hyundai Xcient Truck ER Guide]

[Nicola ER Guide]

Unilia 220 FC



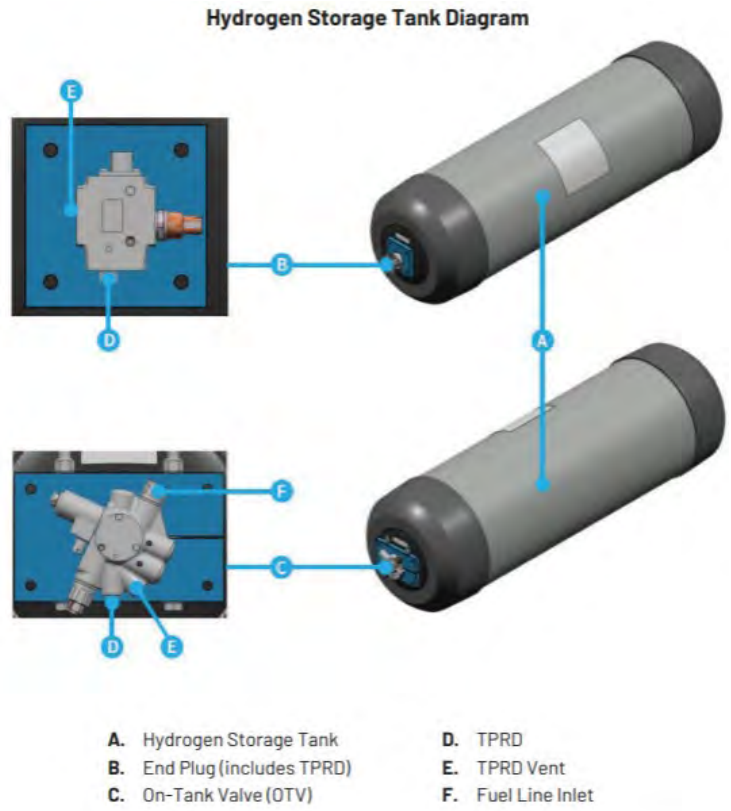
Transportation
H2 STORAGE ON HEAVY DUTY FCETs

Heavy Duty Vehicles General Specifics

Tank Construction	Type IV
Tank Size (water volume)	~175 L
Max Pressure	70 Mpa (700 barg / 10,000 psig)
Number of tanks	4-10
Hydrogen stored on board	~60- 70 kg

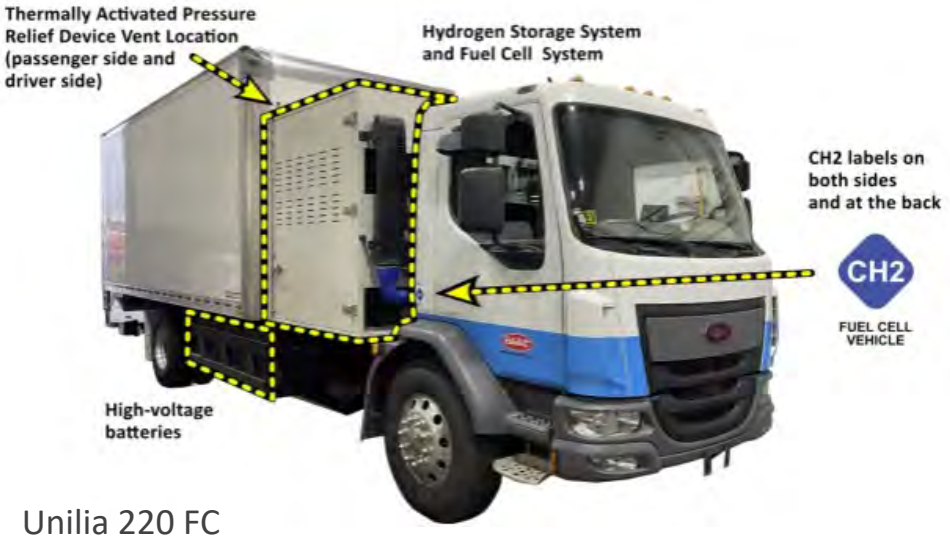
Key Facts:

- In-Tank Pressure Regulator – High pressure hydrogen is only stored inside the tank. In-tank regulators limit the pressure down stream of the tank.
- 14x the amount of hydrogen stored onboard compared to light duty vehicles

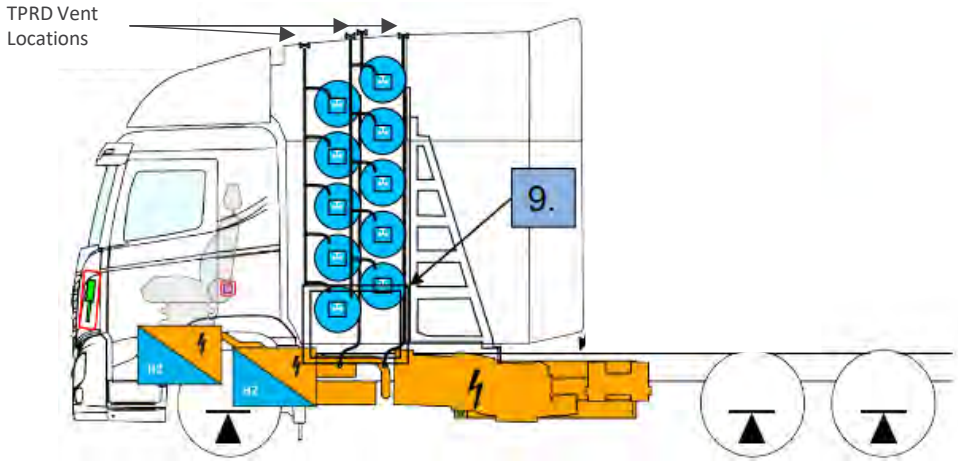


Type IV Tank used in FCET heavy duty vehicles

Transportation
STORAGE TPRDS ON HEAVY DUTY FCETS



Unilia 220 FC



Hyundai Xcient

TPRDs (Thermally Activated Pressure Relief Devices) on heavy duty vehicles are currently located in different locations on vehicle when compared to light duty vehicles

- Activated with heat – 110°C (230°F).
- Exit of TPRD located at top of vehicle and sometimes below vehicle behind the driver's cab.
- Full pressure of tank vented through TPRD.
- Each tank has its own TPRD, on either end of the tank

BASIC RESPONSE CONSIDERATIONS

Transportation
APPROACH ANGLES – LIGHT DUTY VEHICLES

SOURCE: Air Liquide, https://youtu.be/GknSr3yp5Rw

Transportation

BASIC RESPONSE CONSIDERATIONS FOR HYDROGEN FUEL CELL VEHICLES

Over and above standard first responder protocol (see *The EU Emergency Response Guide*)

Arrival

- Ensure fire equipment doesn't cross a flammable gas cloud, arrive upwind of incident scene
- Stop the fire equipment between 50 and 100 meters from incident

Size up the scene

- Determine the incident details - What is the distance between the fire and the fuel cell vehicle? Is hydrogen leaking? Have the TPRDs been activated?
- Should the safety zone be expanded? Determine the energies present in the vehicle involved (tank type, pressures, capacities)

Rescue

- Various tactics can be implemented here depending on the incident, H2 leaks, vehicle on fire, approaching fire, etc.

TACTICS LISTED IN THE EU ER GUIDE

Object Involved	Guide Chapter	Tactic Number	Scenario
Fuel Cell Vehicle	20.1	1	No Leak, No Fire
Fuel Cell Vehicle	20.2	2	H2 Leak without fire
Fuel Cell Vehicle	20.3	3	Vehicle on Fire
Fuel Cell Vehicle	20.3	4	External Fire Threatening the Application
Large Fuel Cell Vehicle	21.1	5	No Leak, No Fire
Large Fuel Cell Vehicle	21.2	6	H2 Leak without fire
Large Fuel Cell Vehicle	21.3	7	Vehicle on Fire
Large Fuel Cell Vehicle	21.4	8	External Fire Threatening the Application

Transportation

BASIC RESPONSE CONSIDERATIONS FOR HYDROGEN FUEL CELL VEHICLES

Over and above standard first responder protocol (continued)

Exposure Protection

- Press the emergency shutdown devices in vehicle
- Repeatly check H2 sensors
- Check for H2 tank temperatures with thermal imaging camera.

Incident Treatment

- DO NOT:
  - cut or crush H2 lines
  - cut or crush High Voltage Lines (orange-coloured)
  - damage hydrogen tank
  - damage traction Battery Stack
- If possible, keep tanks cool with water mist – this will prevent TPRDs from activating, but sometimes this is necessary if extraction is required.
- Extinguish or isolate fire source from H2 storage systems

Final Inspection

- Cool the wreckage as soon as no heat point is detected using the thermal imaging device

DISTRIBUTION TRAILERS

Hydrogen Delivery Trailers
TYPICAL Designs

Bulk hydrogen is transported on the road using 3 general vehicle designs. HTEC's supply chain includes the latter of the two:

1. Gaseous Hydrogen Tube trailer – using steel cylinders (Type I tanks)
2. Gaseous Hydrogen Tube trailer – using carbon fiber cylinders (Type III and Type IV tanks)
3. Liquid Hydrogen Trailer – Vacuum insulated tank

Hydrogen Delivery Trailers
TUBE TRAILER WITH STEEL TANKS

Type of Tank	Type I (Steel)
Typical Size of tank:	2600 L
Max pressure in tank:	22 MPa (220 Barg / 3,200 psig)
Number of tanks on board	~6-36 tanks
Stored hydrogen on board	300-400 kg

Hydrogen Delivery Trailers

TUBE TRAILER WITH CARBON FIBRE TANKS

Type of Tank	Type III or Type IV (Carbon Fiber)
Typical Size of tank:	300 L
Max pressure in tank:	45 MPa (450 Barg / 6,500 psig)
Number of tanks on board	20-60 tanks
Stored hydrogen on board	180 -540 kg

Currently, these delivery trailers have a max pressure of 450 bar, but higher pressure (700 bar) delivery trailers are in design.

Hydrogen Delivery Trailers
LIQUID HYDROGEN TRAILER

Type of Tank	Vacuum insulated, steel tank
Typical Size of tank:	5000 L
Max pressure in tank:	45 MPa (450 Barg / 6,500 psig)
Number of tanks on board	1 tank
Stored hydrogen on board	~4500 kg

BASIC RESPONSE CONSIDERATIONS

Hydrogen Delivery Trailers
INCIDENT RESPONSE

SOURCE: AIChE Academy, https://youtu.be/LsYq9jRkXsg

Hydrogen Delivery Trailers

BASIC RESPONSE CONSIDERATIONS FOR HYDROGEN FUEL CELL VEHICLES

Over and above standard first response protocols

(see *The EU Emergency Response Guide*)

Incident Treatment

- Various tactics can be implemented here depending on the incident, H2 leaks, trailer on fire, approaching fire, etc.
- If the fire concerns an ignited H2 leak, the only safe way to put out the fire is to close the appropriate valve.
- Only extinguish the fire when you can close the leak, otherwise let the H2 burn in controlled circumstances
- DO NOT:
  - cut or crush H2 lines
  - Damage the hydrogen tank
- Keep tanks cool – especially if there is fire
- Extinguish or isolate external fire sources from H2 storage systems

Tactics listed in the EU ER guide			
Object Involved	**Guide Chapter**	**Tactic Number**	**Scenario**
Fuel Cell Vehicle	20.1	1	No Leak, No Fire
Fuel Cell Vehicle	20.2	2	H2 Leak without fire
Fuel Cell Vehicle	20.3	3	Vehicle on Fire
Fuel Cell Vehicle	20.3	4	External Fire Threatening the Application
Large Fuel Cell Vehicle	21.1	5	No Leak, No Fire
Large Fuel Cell Vehicle	21.2	6	H2 Leak without fire
Large Fuel Cell Vehicle	21.3	7	Vehicle on Fire
Large Fuel Cell Vehicle	21.4	8	External Fire Threatening the Application

Hydrogen Delivery Trailers

BASIC RESPONSE CONSIDERATIONS FOR HYDROGEN FUEL CELL VEHICLES

Over and above standard protocol (Continued)

Keeping tanks cool – suggested response

- Gaseous Hydrogen Tube trailer – using steel cylinders (Type I tanks)
  - Spray water directly on tube trailer tanks
- Gaseous Hydrogen Tube trailer – using carbon fiber cylinders (Type III and Type IV tanks)
  - Avoid spraying water on TRPDs – if there is a fire these devices need to activate. Soaking them with water could prevent them from triggering and lead to escalation
  - If possible, to avoid TPRDs, spray water directly on tanks
  - If not possible, create mist spray over entire trailer
- Liquid Hydrogen Trailer
  - Spray water directly on tube trailer

Gaseous hydrogen tube trailer with TPRDs activated. Water mist over trailer keeping tanks cool.

Hydrogen Delivery Trailers
TPRD AND VENT LOCATIONS

Over and above protocol (Continued)

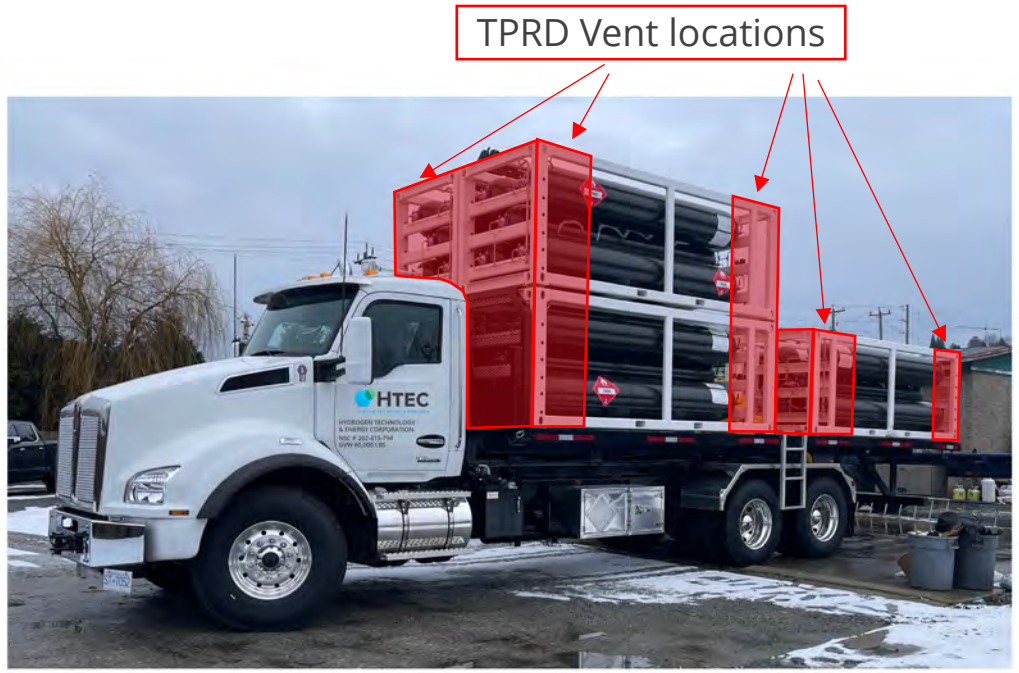
For tube trailers that have Type III or Type IV tanks, like all HTEC tube trailers, TPRDs are located at each of the tank ends.

On an HTEC delivery trailer, there could 4 to 12 modules or PC45s, with each module/PC45 containing 5 tanks.

Usually these PC45s are installed on the truck in ‘blocks’ of 4 modules/PC45s.

Therefore, TPRDs are located within 1m of the ends of these blocks. The TPRD vent exits are routed to the top of these blocks within these same 1m zones.

- These zones on the image to the right are just representative. Actual trailers do not have these zones marked.



DO NOT SPRAY WATER DIRECTLY ON THE TANKS WITHIN THESE RED ZONES.

Water can be directly sprayed on to the tanks between these zones

THANK YOU!

We appreciate your time and commitment to learning about hydrogen safety. Your role as first responders is essential to the safe rollout of this clean energy solution.

Want to learn more?

➡ Continue with our training modules
➡ Email us at info@htec.ca to arrange a workshop, live demo, or tailored presentation for your department.

Together, we can build a safer, cleaner future.