RESCUE GUIDE

TEV75H HYDROGEN RANGE EXTENDED VEHICLE

ISSUE 01 – MARCH 2023

www.tevva.com

INTRODUCTION

This guide is intended only for the use of trained and certified rescuers and first responders. It assumes the reader has full knowledge of how the safety systems operate and completed all of the appropriate training and certification necessary to safely work in, and manage rescue situations.

Therefore, this guide provides only the specific information required to understand and safely handle the vehicle in an emergency situation. It contains important warnings and instructions that must be followed when working with the vehicle in an emergency situation.

Range extended fuel cell vehicles use an electric motor to drive the wheels in the same way as a pure electric vehicle does. The fuel cell is used to simply provide extra energy to the batteries to extend the range of the vehicle.

The fuel cell vehicle is equipped with dedicated high voltage equipment which is not present on a battery only vehicle. Additional high voltage components include: a FC water pump, FC compressor, FC Heater and FC DCDC Converter.

To store the hydrogen required to fuel the fuel cell, hydrogen is stored in high pressure cylinders located rearwards of the cabin. The hydrogen is stored at a maximum of 35MPa (350bar) at 15°C.

In the case of hydrogen leakage, there are multiple hydrogen leak detection methods present on the vehicle that will cause hydrogen supply to immediately shut off.

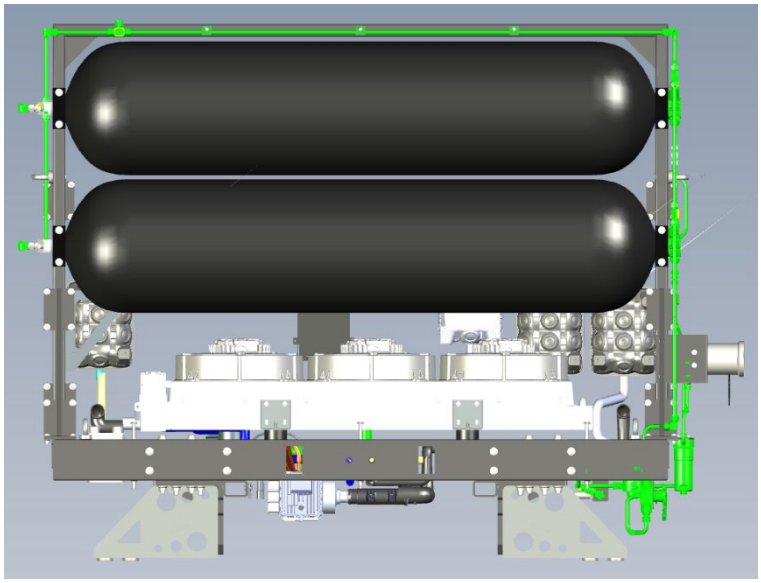
In the event of a hydrogen leak, all hydrogen is directed towards the vent line which is located at the highest point of the vehicle. In most cases, vented hydrogen will escape safely into the atmosphere, free from the presence of potential ignition sources.

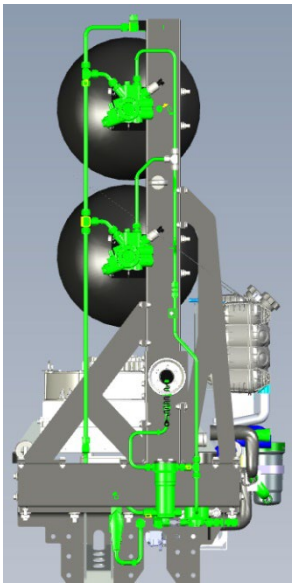
Hydrogen fire detection methods are also used to detect hydrogen fires on the vehicle. A beacon will be illuminated (details to follow) in the event of any hydrogen leak or hydrogen fire.

WARNING

If the sound of a hydrogen leak can be heard, step away from the vehicle in case the hydrogen ignites. Similarly, if the hydrogen concentration around the vehicle is detected to be above 4%, step away from the vehicle and allow the hydrogen to vent safely.

Hydrogen will remain in some of the tube work and the fuel cell even after fuel supply has been shut down. Do not cut or damage the highlighted hydrogen components in any case.





WARNING

Always use the appropriate tools, and always wear the appropriate Personal Protective Equipment (PPE) when you are working on the truck. Failure to follow these instructions can cause serious injury or death.

WARNING

Regardless of the disabling procedure you use, always assume that all of the High Voltage components are energised. Cutting, crushing, or touching High Voltage components can result in serious injury or death.

WARNING

After deactivation, the high voltage circuit requires 30 minutes to de-energise.

WARNING

When there is fire involved, always consider the entire truck as energised and do not touch any part of the truck. Always wear full PPE, including Self-Contained Breathing Apparatus (SCBA), high voltage safety gloves (approved to IEC/EN 60903 standards), goggles and boots. Remove all metallic jewellery, including watches and rings. Failure to follow these instructions may result in serious personal injury or death.

WARNING

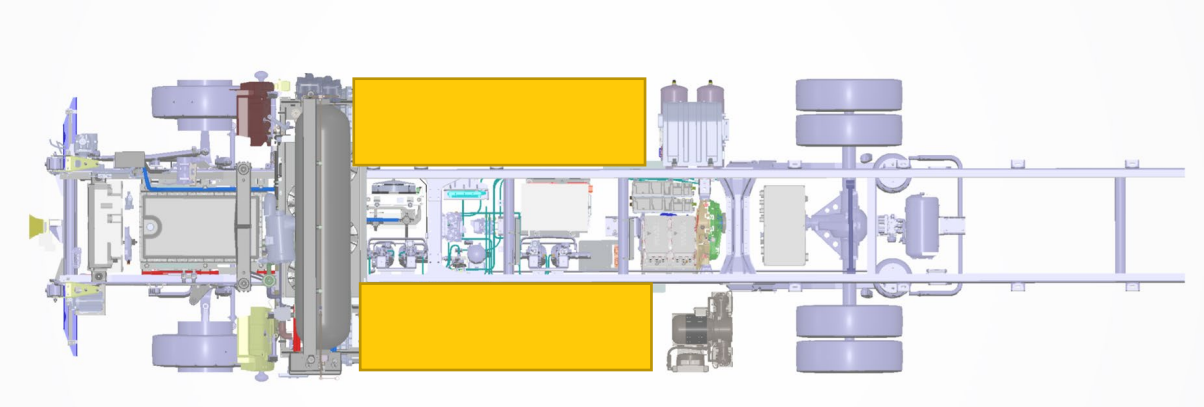
Handling a submerged truck without the appropriate PPE can cause serious injury or death.

HIGH VOLTAGE BATTERY PACKS

Observe the following precautions when working on or around high voltage batteries:

- Do not cut or attempt to open the high voltage battery case or expose to excessive external force
- Do not penetrate the batteries or case in any way
- The high voltage battery packs are located to the side members of the chassis and under the cabin.
- The total voltage of the battery pack is approximately 400 volts DC
- The battery case is water resistant with connectors in place
- The battery cells contain a base electrolyte consisting of lithium hexafluorophosphate and organic solvents as the dominant active ingredient, absorbed in special polymeric film. The electrolyte will not leak from the battery under most conditions. However, if the battery is crushed, it is possible for electrolyte to leak.
- If possible, isolate and avoid contact with any electric vehicle components. If contact with the high voltage system cannot be avoided, Personal Protective Equipment (PPE) such as safety goggles, high voltage safety gloves (approved to IEC/EN 60903 standards), an apron or overcoat, and rubber boots are required when handling damaged batteries. Exposure to electrolyte could cause skin and/or eye irritation/burns. If exposed, rinse with large amounts of water for 10-15 minutes.

Observe the no step zones (marked in yellow) below:

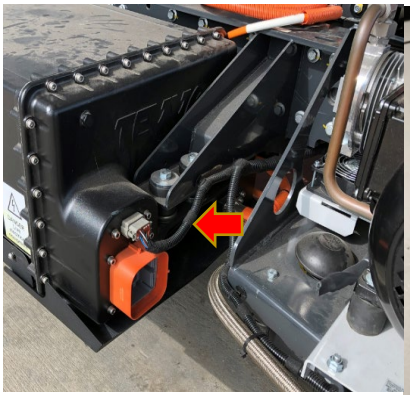


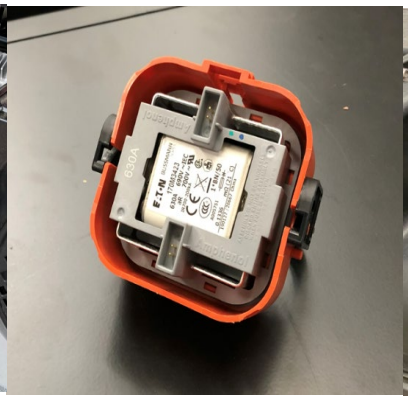
HOW TO VERIFY IF THE TRUCK IS SAFE TO APPROACH

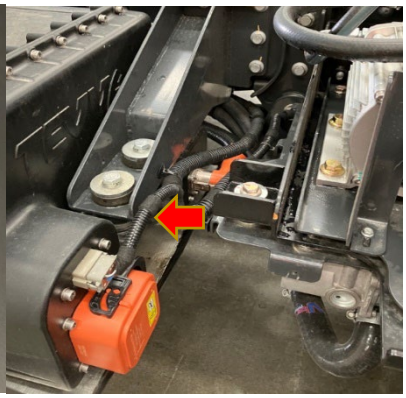
Visually check the truck for signs of external damage. Pay attention to the front, rear and underside of the truck.

If there is extensive body damage, visually check that no high voltage cabling is exposed or badly damaged, to the point where the orange insulation has been removed, exposing bare wires. If damage is seen on high voltage components such as the motor, charger, inverter or battery or if any high voltage wire is exposed, then access to the ignition switch on the steering column should be gained by breaking the driver's window. The key should be switched to the off position and removed.

If the above checks do not raise any concerns, then isolate the truck by locating and removing the Manual Service Disconnects (MSDs) fitted to both of the two side batteries.







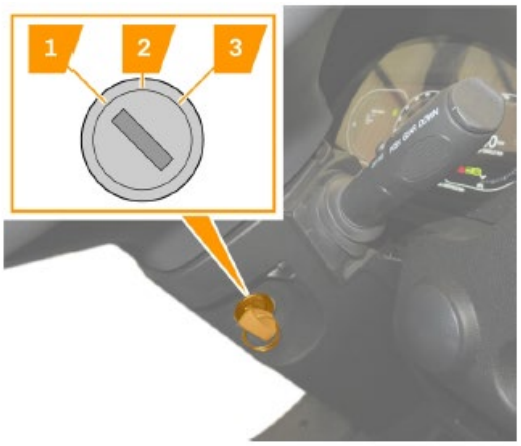
When these checks have been completed, it should then be safe to continue with the incident response.

If the MSDs cannot be removed, and as a last resort in an emergency, the low voltage wiring to each of the side batteries can be cut through (as indicated by the arrows above) using suitable insulated cutters. This will isolate the power to the battery contactors and should make the vehicle safe to work on.

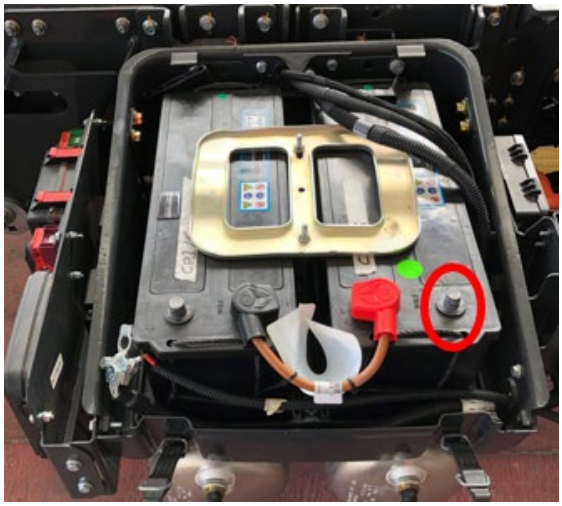
WARNING

Removing the high voltage Manual Service Disconnects (MSDs) does not dissipate voltage inside the battery. The battery pack retains charge and should still be considered dangerous. Contact with the high voltage battery pack internals may result in serious personal injury or death.

Disable vehicle by removing the key from ignition if possible. (Turn to position 1). If step 1 cannot be completed, skip straight to step 2 to remove Low Voltage power.



Remove negative terminal of 24V (2x 12V) batteries. This ensures that the fuel cell and rest of vehicle is isolated, and that power is removed from the hydrogen tank valves- shutting off hydrogen supply. (13mm spanner required). Take extra care not to touch other surfaces whilst removing a battery terminal, especially with a spanner. This can cause arcing and welding of the terminals.



ESSENTIAL TOOLS AND EQUIPMENT

Appropriately rated and insulated automotive hand tools should be used on the truck. Care should be taken to ensure isolation procedures have been followed prior to commencing any work, repairs or emergency access activity.

HAZARD IDENTIFICATION

Following an incident that has caused catastrophic damage to the battery assembly, either as a result of fire or crushing, leakage of specific chemicals or combustion products could cause concern. The severity of any incident must be significant to achieve penetration of the outer battery casing and the inner box before the individual cells can be damaged. Potential for exposure should not exist unless the battery leaks, is exposed to high temperatures or is mechanically, physically or electronically abused.

PROVIDING FIRST AID

Emergency first responders may not be familiar with specific electric and hydrogen vehicle hazards. The risk is relatively small if proper measures are carried out and could only appear due to a catastrophic crash or through gross mishandling. If there is any visual evidence of damage to or near high voltage cables and components, then great care should be taken when approaching the truck. If persons are trapped, specifically if they are in contact with any damaged high voltage cables or components then they MUST be initially removed from such contact using an approved, insulated rescue hook.

In the event of such potential exposure, it is always important to wear relevant PPE. This includes goggles, high voltage safety gloves (approved to IEC/EN 60903 standards), and protective clothing with electrical resistance and isolating properties. All persons contaminated by or exposed to leaking fluids should be referred to a medical facility for treatment.

IN THE EVENT OF FIRE

Always assume the high voltage batteries and associated components are energised and fully charged. Lithium-ion battery cells are difficult to extinguish as they create oxygen when burning and are therefore self-sustaining. A Class ABC powder-type extinguisher should be used to contain and smother the flames. Water can cause some degree of arcing/shorting across battery cells and/or battery terminals; it can also react with the electrolyte from the cells to generate additional combustible gas and other by products such as hydrofluoric acid. However, the cooling and smothering effects of flushing the affected article with large amounts of cold water is still beneficial for minimising the severity of the event. Do not use salt water as this can cause batteries to explode.

Under no circumstances should the batteries be removed from the truck or opened in the event of an incident as the live high voltage connections could be exposed.

Hydrogen gas is colourless, odourless but extremely flammable and can ignite in a wide range of concentrations (4%–74.5%). If the sound of hydrogen leaking (a loud hissing sound) can be heard or if the hydrogen concentration around the vehicle, when measured with a hydrogen concentration detector, exceeds 4% there is a chance that the gas may ignite.

The temperature of a hydrogen fire is very high but the amount of heat that radiates from the flame is small. It is unique in that it is difficult to feel the heat even in close proximity.

In the event of a hydrogen fire, use excessive amounts of water on the vehicle's hydrogen storage system, located behind the cabin, to COOL the area. If the hydrogen is on fire, it is usually safer to spray water to prevent the flame from spreading to surrounding areas. The main flame should be left to naturally burn itself out as the flame will most likely be controlled.

In the event of hydrogen leakage or escape, hydrogen should be directed towards the vent line. The vent line is designed to be free from any potential ignition source. If temperatures exceed 85°C, the TPRD (Temperature and Pressure Relief Devices) will activate and cause the hydrogen to be released via the vent line.

SUBMERGED VEHICLES

Damaged electric and hydrogen vehicles submerged in water present a potential high voltage electrical shock hazard. Exercise caution and wear appropriate Personal Protective Equipment (PPE) including high voltage safety gloves (approved to IEC/EN 60903 standards), goggles and boots. Remove all metallic jewellery, including watches and rings.

If the truck is submerged in water, varying degrees of arcing/shorting within the battery will take place. Do not touch any high voltage components or orange cables while removing occupants. Do not remove the truck until you are sure the high voltage battery is completely discharged. A submerged high voltage battery may produce a fizzing or bubbling reaction to the water. If fizzing or bubbling is observed, the high voltage battery will be discharged when the fizzing or bubbling has completely stopped. The battery should still be treated as if it is not discharged. If the vehicle is submerged in salt water there is a risk of explosion.

If any hissing or obvious leaks are present in the water, treat with caution and allow the hydrogen to vent completely before removing the vehicle.

The removeable towing eye can be fitted to the truck through a detachable cover in the front bumper. If access to the towing eye is not possible then a tow rope should be securely fastened to the vehicle underside using the rear axle or front lower suspension as fixing points. This process MUST ONLY be used for immediate recovery from the water.

Once the truck has been removed from the water, any water should be drained before transporting.

Failure to follow these instructions may result in serious personal injury or death.

OCCUPANT EXTRICATION AND DO NOT CUT ZONES

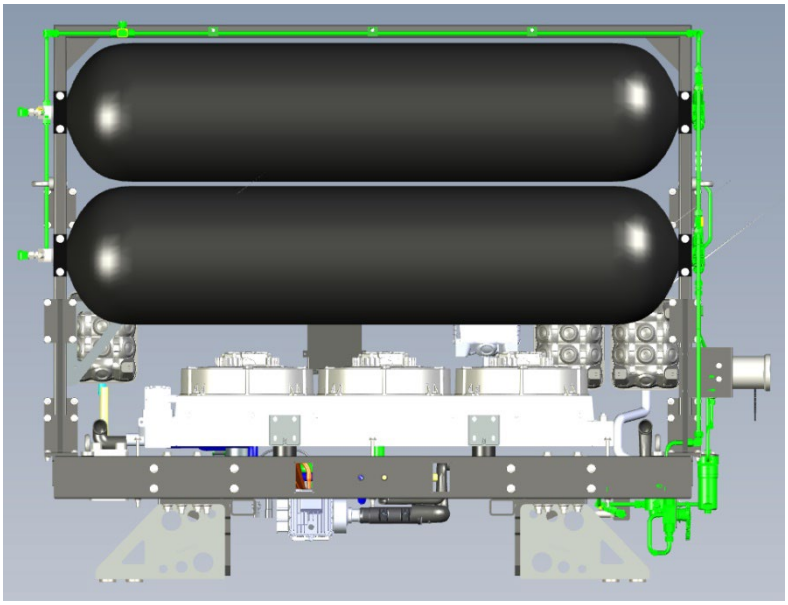
Once the truck has been electrically isolated and, if necessary, stability has been restored, then occupant extrication can be completed following standard operating practice. Always use caution when cutting near the truck high voltage system components. Do not cut any of the high voltage under truck or under cabin cabling (all high voltage cabling is orange). High voltage cabling runs from the batteries and components under the cabin, along the chassis to side batteries and centrally mounted high voltage components. The charge port is located on the left side of the truck.

Even after the truck is stopped, hydrogen remains in the FC stack, hydrogen tanks and other hydrogen related parts, as well as inside the hydrogen pipe. To avoid fires and explosions, never cut or damage these hydrogen related parts or the hydrogen pipe.

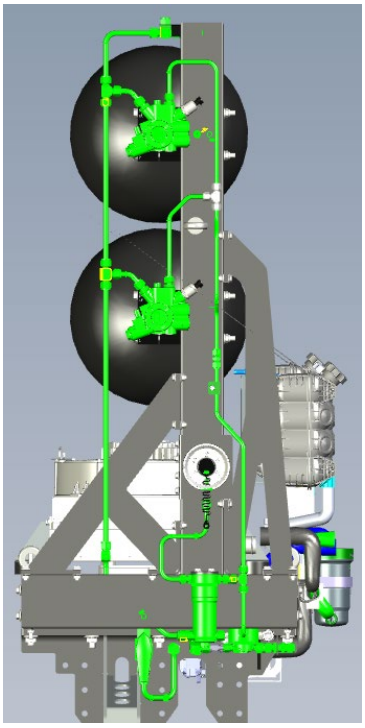
If there is any hydrogen leakage, do not use any electrical or rescue equipment that may produce static electricity, as this may ignite the hydrogen.

The hydrogen pipes connect the hydrogen related parts such as the FC stack and the hydrogen tanks. The hydrogen pipes are located as shown in the diagrams below.

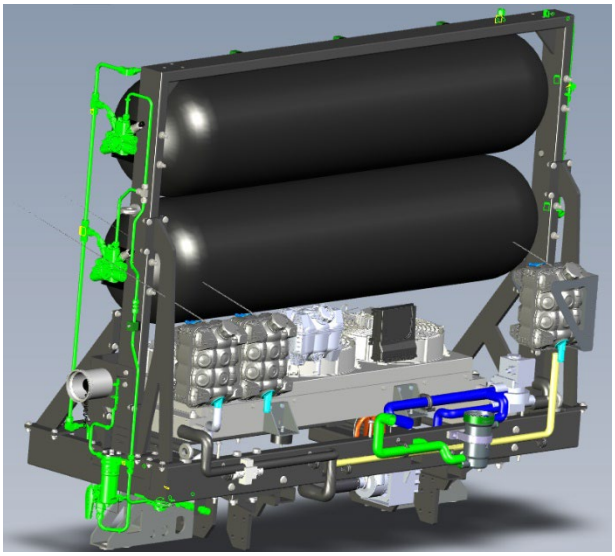
There is a possibility of explosion due to ignition of the hydrogen gas generated from the 12V battery. Therefore, do not allow any open sparks or open flames near the 12V batteries.



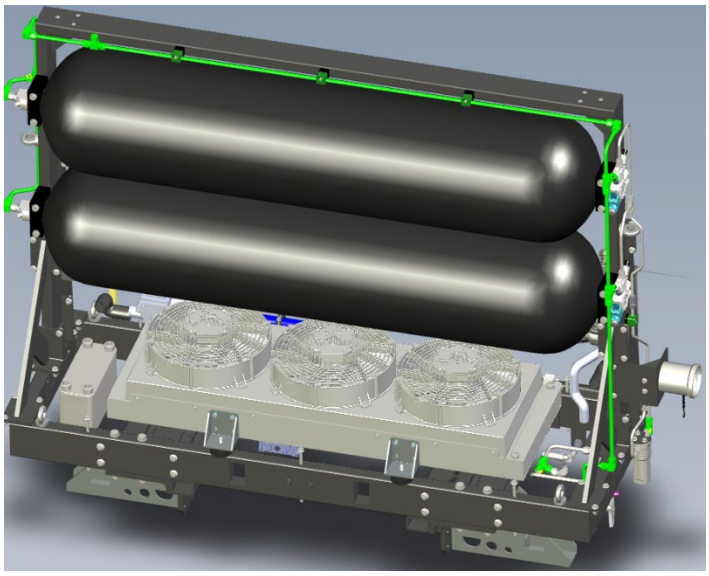
Hydrogen Tubing Overview



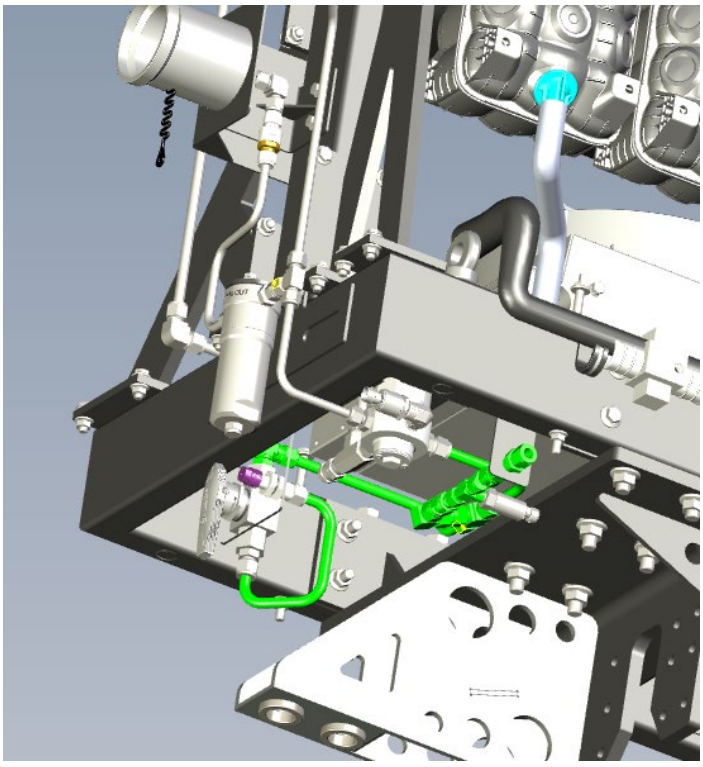
Hydrogen Tubing Overview RHS



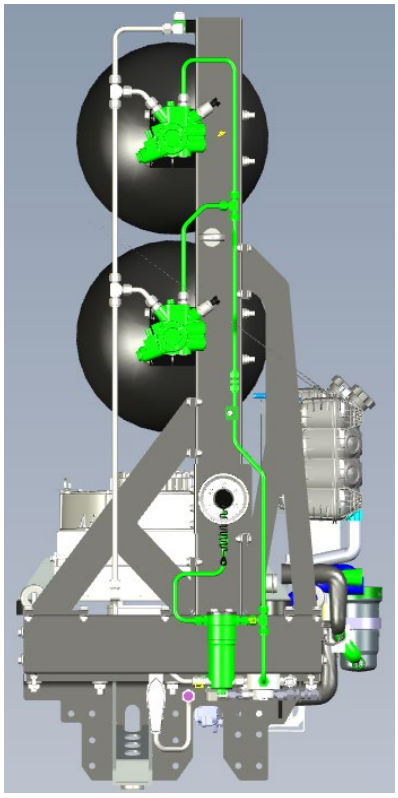
Hydrogen Tubing Overview: Isometric



Hydrogen Tubing Vent Lines



Hydrogen Medium Pressure Lines (8.5 to 14bar)

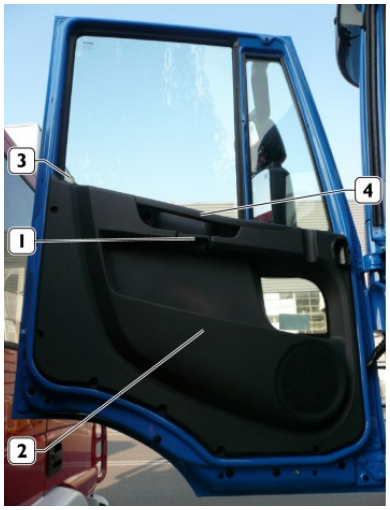


Hydrogen High Pressure Lines
(3MPa-35MPa/30bar to 350 bar)

ACCESS TO THE TRUCK

Doors

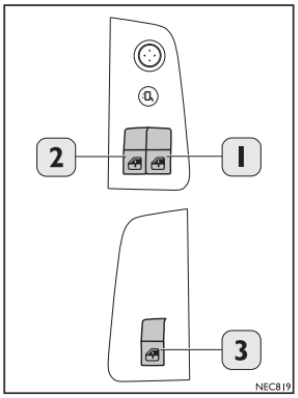
When the doors are open the two external light fixtures on the upper cross member and the white internal ceiling light illuminate. The external light fixtures switch OFF when the doors are closed (they are timer-controlled).



1. Lever for opening the door
2. Document pocket
3. Knob for locking the door from the inside
4. Handle for closing the door

Power Windows

The power window controls for both driver (1) and passenger windows (2) are located on the driver door side. The passenger can only operate the windows on the passenger side (3).



STEERING WHEEL ADJUSTMENT

If movement of the steering wheel or column position is necessary, loosen the adjusting lever on the steering column by rotating it counterclockwise until it stops.

Hold the steering wheel with your hands and adjust it by pulling it up or down to adjust the height. Push it forwards or pull it towards you to adjust the depth.

Seat Adjustment

If movement of the seat position is necessary:

Height adjustment

1. Lift lever to release the seat
2. Adjust height and release lever to lock

Seat back adjustment

1. Lift lever to release seat
2. Adjust seat back and release lever to lock

Forward and rearward adjustment

- Lift lever to release seat
- Slide forward or backwards and release lever to lock

Seat base adjustment

1. Lift lever to release seat
2. Tilt seat base up or down and release lever to lock

MOVING DAMAGED TRUCKS

Select neutral and apply the parking brake, ensure the truck is switched off, activate the hazard lights, and remove the key from the vehicle until loading the vehicle for transport.

If you detect leaking fluids, sparks, smoke, flames, increased temperature, gurgling, popping or hissing noises from any of the high voltage battery compartments or electrical components, ventilate the passenger area and call the emergency services.

Always be alert. There is a potential for delayed fire with damaged lithium-ion batteries.

Avoid contact with orange high voltage cabling and areas identified as high voltage risk by warning labels.

RECOVERING THE TRUCK

The truck should either be recovered on a flatbed recovery vehicle to avoid any possibility of causing further damage to the electric drivetrain and related systems or on a suspended tow below 30mph. If the vehicle is towed above 30mph, the prop shaft must be disconnected and supported.

Ensure there are no persons or objects behind the recovery vehicle when the vehicle is pulled onto the flatbed platform or tow truck.

DAMAGED TRUCK STORAGE

Recovery vehicle operators of tow trucks and vehicle storage facilities should ensure the damaged truck is kept in an open area instead of inside a garage or other enclosed building and not within 15m (50 ft) of any structure or vehicle.

Whilst located in the storage area or parking lot, continue to inspect vehicle for leaking fluids, sparks, smoke, flames, gurgling or bubbling sounds from the high voltage battery. Hydrogen vehicles may leak gas due to damage incurred during an accident. The remaining hydrogen may ignite causing a fire or explosion.

Ensure the passenger and cargo compartments remain ventilated at all times and call the emergency services if any of the above scenarios are detected.

TEVVA LONDON – Unit 1, London Distribution Park, Windrush Road, Tilbury RM18 7EW

www.tevva.com