HYUNDAI

XCIENT Fuel Cell

Emergency Response Guide

HYUNDAI HELP LINE
0800 HYUNDAI (498 632)

Important Safety Information

This manual includes information titled as DANGER, WARNING, CAUTION & NOTICE.

These titles indicate the following:

⚠ DANGER

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE indicates a situation which, if not avoided, could result in vehicle damage.

⚠ WARNING

- Compressed Hydrogen gas is stored on-board XCIENT Fuel Cell in 7 separate tanks. Hydrogen is extremely flammable, is odorless, colourless, tasteless & would burn with an invisible flame – extra is required.
- If severe damage causes high-voltage components to become exposed, emergency responders should take appropriate precautions and wear appropriate insulated personal protective equipment.
- Do not attempt to remove the safety plug while standing in the water.
- Never cut or disconnect the high voltage orange cabling and connectors without first disabling the system by removing the safety plug.
- Exposed cables or wires may be visible inside or outside the vehicle. Never touch the wires, cables, connectors, or any electric components before disabling the system, to prevent injury or death due to electrical shock. Failure to follow any of these instructions may result in serious injury or death by electrocution.
- Do not cut through any component of the Airbag (SRS) system (Supplementary Restraint System)
- SRS components may remain powered and active for up to 3 minutes after the 24V electrical system is shut off or disabled. Disconnect the battery negative cable and wait for at least 3 minutes before beginning work. Failure to follow any of these instructions may result in serious injury or death from accidental deployment of the airbag system.

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Contents

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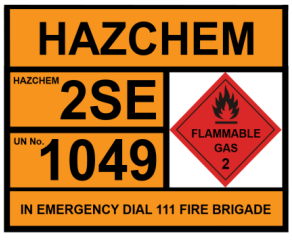
- In an emergency call 111



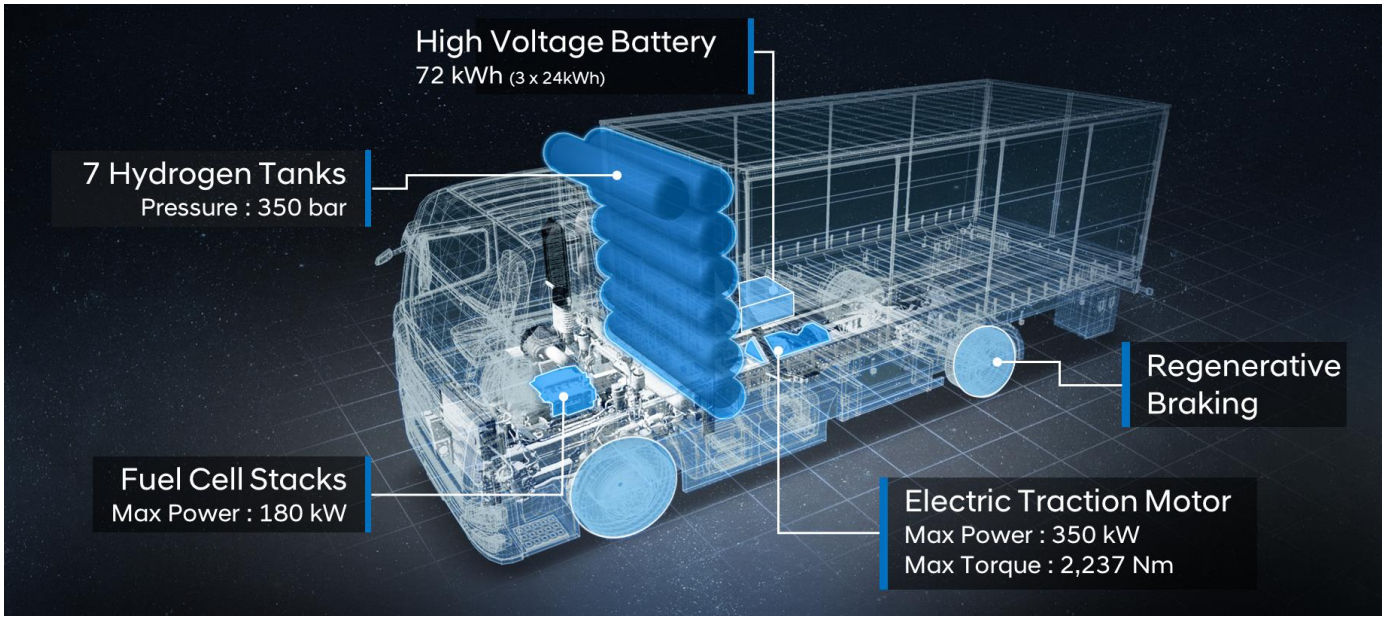
Introduction

Document Purpose

The purpose of this document is to familiarise emergency responders and the towing/roadside assistance industry with the proper methods to handle the Hyundai XCIENT Fuel Cell Electric Truck in an emergency situation. This guide offers a basic overview of key vehicle systems and provides instructions for dealing with the different types of situations encountered by emergency responders. The emergency response procedures for this vehicle are somewhat similar to a conventional vehicle, with additional information provided on dealing with the high-voltage electrical and compressed hydrogen system.

Truck Description

A hydrogen electric truck is a truck that generates electrical energy through a fuel cell system. While regular trucks use a diesel internal combustion engine, fuel cell electric trucks use electrical energy that is produced by the reaction of hydrogen gas and oxygen. As a result, fuel cell electric trucks are eco-friendly since they do not emit exhaust/carbon gases – only clean air and water vapour. When decelerating or driving downhill, regenerative braking is utilised to charge the high voltage battery. This minimises energy losses and increases the range of the truck.



High Voltage Safety System

Fuel Cell Stacks

Hydrogen electric trucks, unlike regular diesel powered trucks, use high voltage electrical energy generated in the fuel cell stacks as a power source. Due to this high voltage electricity, the truck requires careful handling due to the high voltage hazards. The following items are safety guidelines of the high voltage in the fuel cell stacks of XCIENT Fuel Cell.

1) A metal chassis and electro-conductive enclosure is located in the fuel cell stack to prevent an electrical shock due to the direct or indirect contact of users. The fuel cell stack has a high protection degree of IPXXB.

2) Live parts and high voltage buses, which are generating over 400V DC in each fuel cell stack, are designed to maintain a reliable insulation resistance with an electro-conductive enclosure. When the insulation resistance is lower than a specified value, the user is notified and the output current of fuel cell stack is limited.

High Voltage Battery System

This system supplies the energy which is applied during vehicle acceleration. The system is also used to store the energy generated during regeneration braking.

1) The high voltage system is located on the right side and is protected with a steel case.

2) The system nominal voltage is 630V DC and each cell is sealed with an aluminum case to protect against an electrolyte spillage. There is a rare possibility that the electrolyte in the cell will spill, even if the battery module is damaged.

3) For safety, an over-current protection and ceramic coating isolation layer are used.

4) Non-flammable electrolyte material is used to prevent explosions or fire in an emergency case such as a car accident.

5) High voltage cables (orange colour) connect the battery system to the DC converter.

6) There is a high voltage regulator used to control the high voltage line. In addition, a high voltage fuse and a safety plug are used to separate the electrical sources in the system for safety.

Safety Issues of Compressed Hydrogen

General Characteristics of Hydrogen

Hydrogen is a gas with the smallest molecular weight of all gasses. It is colourless, odorless, tasteless, and noncorrosive with combustibility and fast diffusivity. It needs to be handled with caution.

However, hydrogen is not dangerous in any other way and could even be less dangerous than other fuels in some aspects. Since hydrogen is the lightest element, it rapidly rises and disperses in the atmosphere without mixing with the air. Hydrogen is relatively safe as it does not easily reach the concentration for explosion.

Hydrogen Gas Features

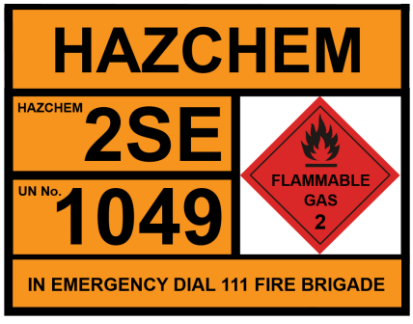
A hydrogen gas leak should be prevented to minimise the hazard of ignition or detonation.

The followings are properties of gaseous hydrogen.

- → It has the lowest molecular weight, and is the smallest molecule of any element.
- → It as the lowest density and the highest buoyancy of any element.
- → It can cause brittleness in some materials, including metals (materials chosen for hydrogen applications are not susceptible to brittleness).
- → It is colourless, odorless and tasteless.
- → It burns invisibly and without smoke.
- → It has the lowest ignition energy of any fuel (less than one-tenth that of other fuels).
- → It has a wide flammability concentration range of 4% to 75%

Diffusion Velocity Ratio of Diffusion & Flow in the air

Gas	CH_4	C_3H_8	H_2
Diffusion	1.0	0.63	3.8
Turbulent Flow	1.0	0.6	2.83



Hydrogen Gas Leak Detection System

The hydrogen gas detection sensor detects a hydrogen leak. If there is a leak, the hydrogen storage system and electrical systems will be shut down. Sensors will illuminate a warning light when concentrations reach the minimum flammability limit of hydrogen.

Sensors are installed at the fuel cell stack, fuel suppling system, and in between the hydrogen storage tanks. These sensors detect a hydrogen leak under emergency situations, allowing the system to block the hydrogen.

Safety Precautions for Hydrogen Electric Vehicle

The XCIENT uses approximately 250~450V DC voltage and high pressure hydrogen gas. Be sure to follow the safety instructions below. Failure to follow the safety instructions may result in serious injury or death.

[Safety precautions for the hydrogen system]

NOTICE

From a safety point of view, hydrogen gas leaks should be prevented due to the possibility of ignition or detonation.

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→ It has a wide flammability concentration range of 4% to 75%

⚠ WARNING

→ Ignition sources should not be near the vehicle. For example, exposed flame, sparks, electrostatic discharge or hot surfaces that could cause hydrogen gas to ignite.

→ Caution labels for hydrogen are attached to the hydrogen storage system components.

→ The hydrogen storage system is composed of seven cylinders and are filled with compressed hydrogen gas. Each tank is made of aluminum and covered with carbon fiber, which allows the storage tank to sustain high pressures. This cylinder contains flammable gas under high pressure (up to 350bar). Serious injury or death can result from improper installation, lack of maintenance or overfilling. Do not attempt to remove this cylinder or any of its fittings from this vehicle. It may contain residual gases under pressure, which could cause a fire or explosion.

[Safety precautions for the high voltage system]

⚠ WARNING

→ Warning labels for high voltages are attached to the high voltage components. The colour of the high voltage cables and connectors are orange. Do not touch any of these high voltage components, cables, and connectors without proper Personal Protection Equipment (PPE).

XCIENT Identification

General Vehicle Description

The Hyundai XCIENT hydrogen electric vehicle is built on a chassis specifically developed to handle the fuel cells. The safest method is to assume that the XCIENT you respond to is equipped with high voltage and hydrogen systems because the XCIENT is an exclusive hydrogen electric vehicle model. Using the information provided in this section, responders will be able to identify the XCIENT.

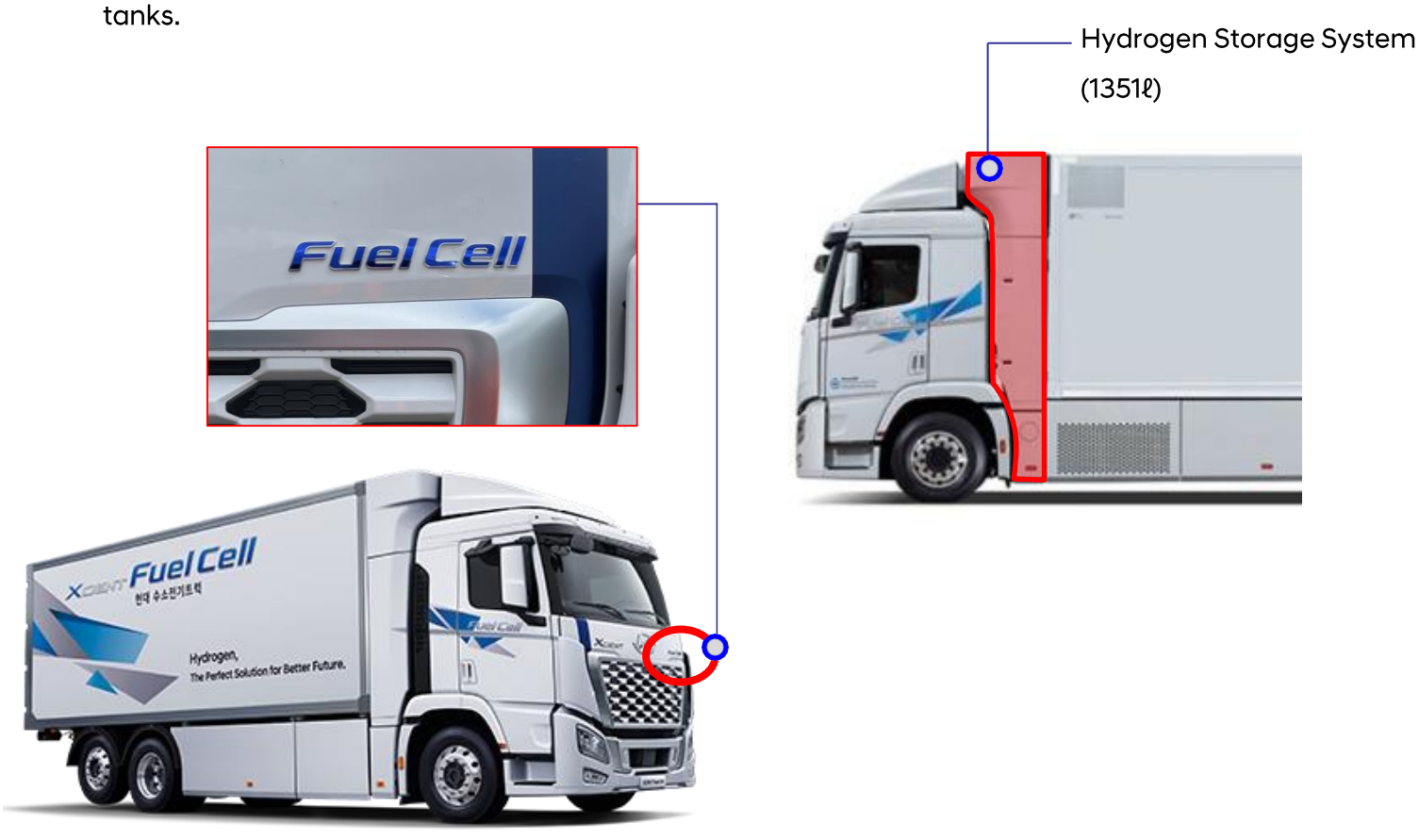
Identifying a Hyundai XCIENT Fuel Cell Truck

LACK OF ENGINE NOISE DOES NOT MEAN VEHICLE IS OFF. SILENT MOVEMENT OR INSTANT RESTART CAPABILITY IS POSSIBLE UNTIL VEHICLE IS FULLY SHUT DOWN.

'XCIENT' Fuel Cell badging & Design Features

The Hyundai XCIENT can be easily identified by the 'XCIENT' name plate, the 'Fuel Cell' badge located on the tailgate, the '.

Badging can become hidden after a crash due to damage to the vehicle. Always be sure to utilise additional methods as necessary to identify the vehicle if there is no badge present. Another identifier, is the Hydrogen Storage System, which consists of 7 large hydrogen storage tanks.



XCIENT Identification

VIN Number

The Vehicle Identification Number (VIN) identifies an electric vehicle with a "**Y**" displayed in the 8th position, as shown in the below drawing.

The VIN is embedded on the floor under the passenger seat. The number "**Y**" in the 8th character of the VIN indicates that it is a Fuel Cell Electric Truck.

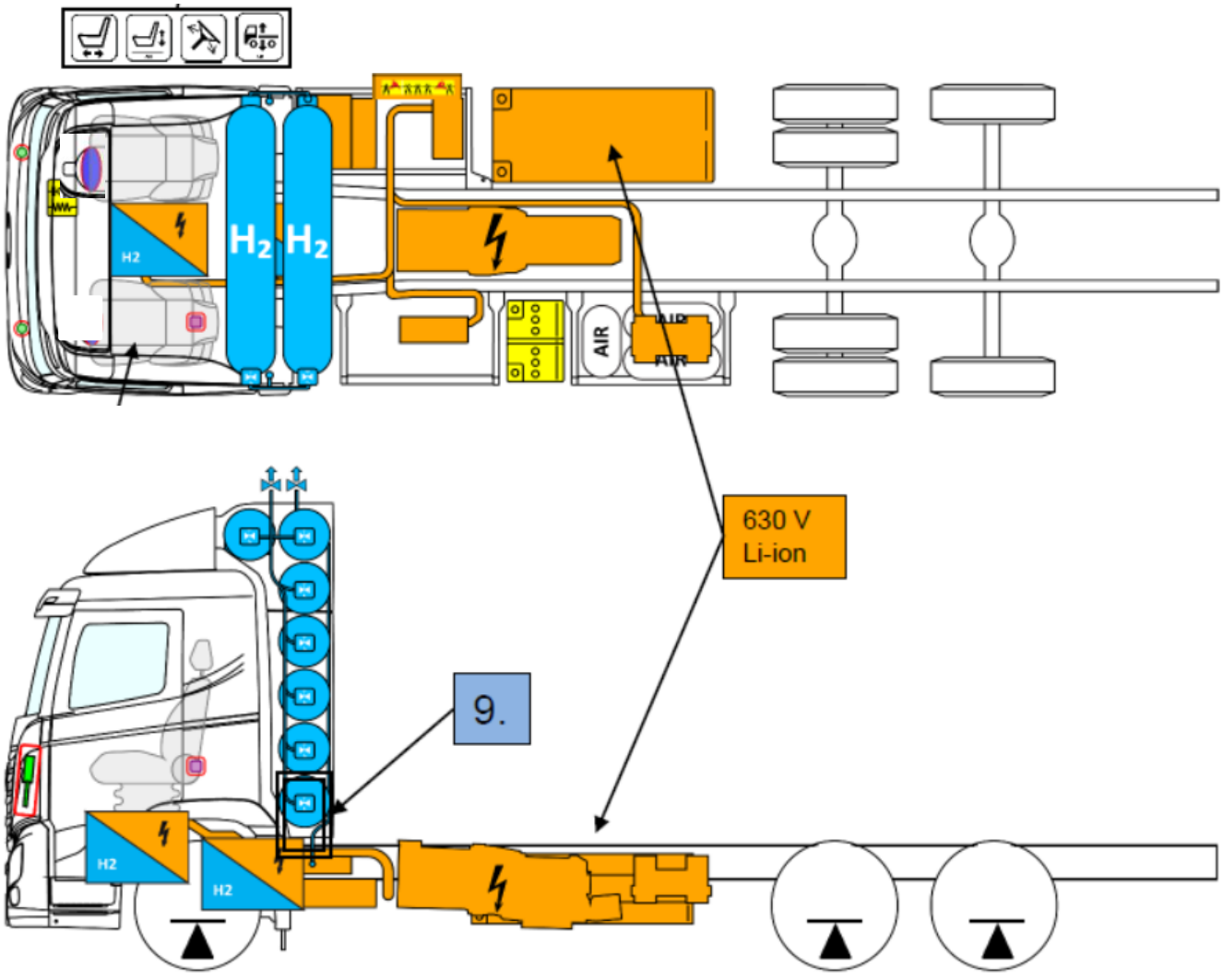
Example : KMFFB18YPNC028196

XXXXXXXYXXXXXXX

8th digit

XCIENT Identification

Fuel Cell System Component Locations



Airbag	Seat belt pretensioner	Gas strut/ Preloaded spring	SRS control unit	Battery low voltage
Battery pack, high-voltage	High voltage power cable	High voltage component	Cable cut	Fuel cell component
Gas tank with gas type indication (H2)	Manual gas shut-off valve with gas type indication (H2)	Gas line (H2)	Direction hydrogen overpressure safety valve in vehicle	Lifting point; central support
Seat adjustment, longitudinal	Seat height adjustment by air system	Steering wheel, tilt control	Height control truck, by air system	Air tank
Special attention				

XCIENT Identification

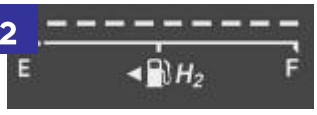
Hydrogen Electric Truck - Cluster Instrument Panel

The instrument cluster panel displays the vehicle's specific features that identify the XCIENT as a hydrogen electric vehicle.

1

: Regeneration brake/ECO/power gauge

2



: Hydrogen fuel gauge indicates the approximate amount of fuel remaining in the fuel tank

3

: The "Ready" Light indicates the vehicle is ready for driving.

4

: Power Down Warning Light indicates that there may be a malfunction with the fuel cell stack. When it comes on during driving, the vehicle power will be limited.

XCIENT Main Systems

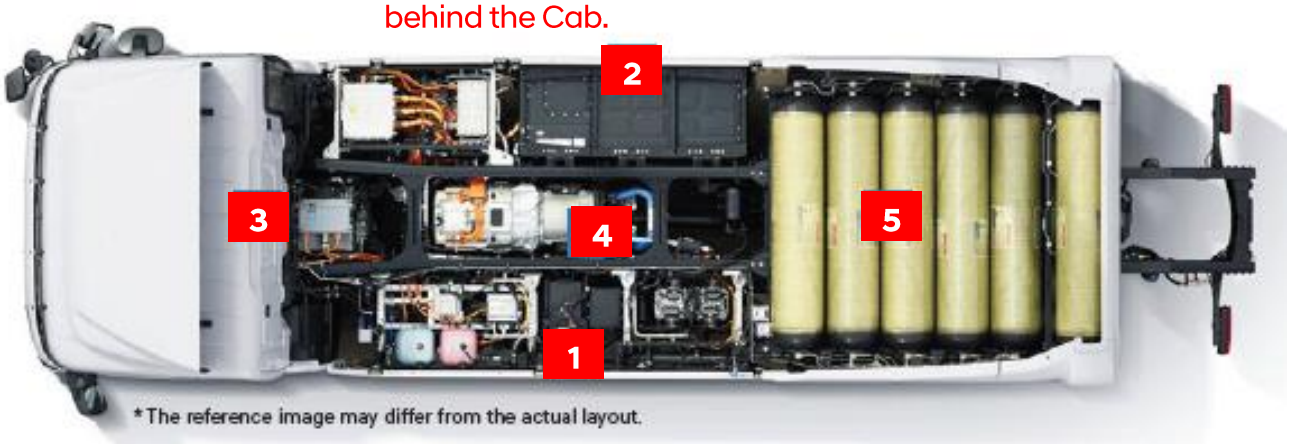
Key Specifications

Item		Value
Electric Driving Motor	Type	Permanent Magnet Synchronous Motor
	Max. Output (kW)	180
	Max. Torque (Nm)	2,237
Transmission	Automatic	6 Speed Allison
Inverter	Input Voltage (V)	240~450V
BHDC	Input Voltage (V)	160~275.2V
	Output Voltage (V)	250~450V
LDC	Input Voltage (V)	250~450V
	Output Voltage (V)	24V
Hydrogen Fuel Tank	Capacity (ℓ)	1,372ℓ (196 x 7) or 31kg
Stack	Max. Output (kW)	90 x 2
	Output Voltage (V)	250~450V (each)
High Voltage Battery	Type	Lithium-ion polymer
	Rated Voltage (V)	630
	Energy (kwh)	72
	Weight (kg)	215

XCIENT Main Systems

Vehicle Components

H2 Storage Tanks (1), in the image are shown in their "transportation position" - Once truck is on the road, H2 tanks are positioned behind the Cab.



24V Auxiliary Batteries (2x12v)

The 24v auxiliary battery is the same as a standard diesel truck. Located on the (mid-left) side of the truck.

These battery supply power to all the standard electric devices such as the audio and instrument cluster. Also, the battery supplies power to the control unit which controls the flow of the high-voltage current and supply of hydrogen.

1

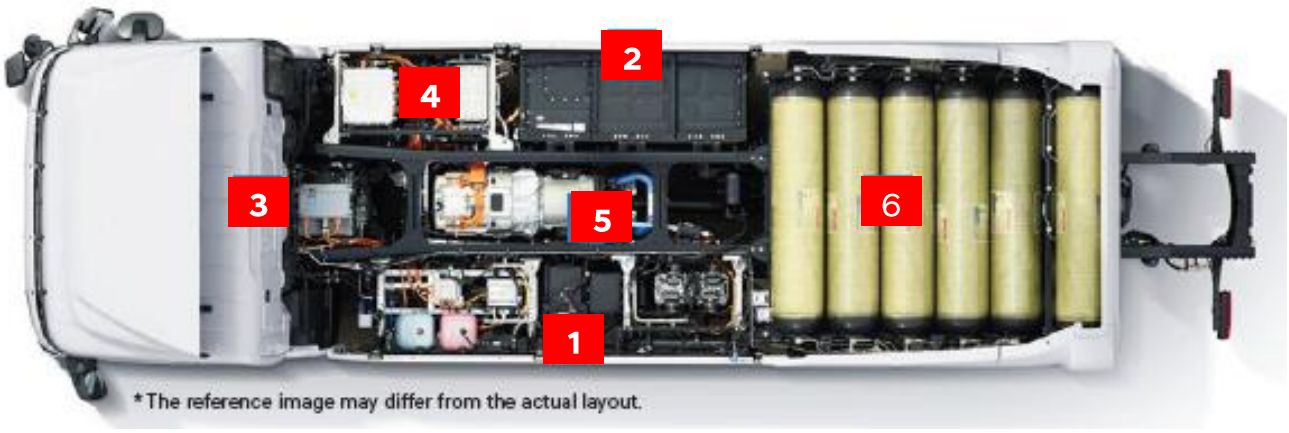
High-Voltage (HV) Battery

The Lithium-ion Polymer HV battery contains a gel electrolyte and is made up of 7 modules. Wired in series for a nominal voltage of 630V with a total energy capacity of 72kWh. The HV battery is located on mid-right side of the truck.

2

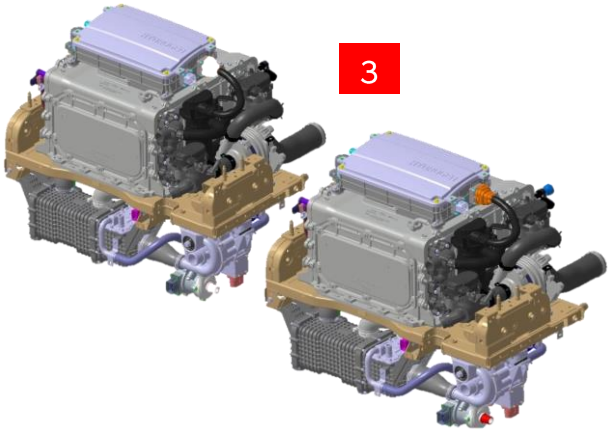
XCIENT Main Systems

Vehicle Components



Fuel Cell System

The fuel cell system is composed of 2 x the fuel cells which generates electric energy through a electro-chemical reaction between the hydrogen and oxygen, the hydrogen supply system which supplies the hydrogen (fuel), the heat control system which manages the heat and the air supply system which supplies oxygen. The electricity generated by the fuel cell system powers the high-voltage battery and the electric traction motor which makes the truckmove.



XCIENT Main Systems

Motor Control Unit

4

The inverter drives the motor of a fuel cell electric vehicle (FCEV). When the MCU (inverter) receives the driver's required torque command (VCU), the DC current of the high voltage battery is changed to AC current required for driving the motor.
That is, it converts the DC power (+, -) from the high voltage battery into 3-phase AC power and controls it via the signal from the control board to drive the motor. During acceleration, the high voltage battery provides additional power to the motor. During deceleration, the energy generated by the motor is used to charge the high voltage battery and thereby increase the driving distance.

Electric Drive Traction Motor

5

Mounted in fuel cell power module compartment with the automatic transmission, the Electric Traction Motor is used for truck propulsion.

During deceleration or braking, it acts as an generator and charges the high-voltage battery by converting the vehicle's kinetic energy into electrical energy.

Automatic Transmission

5

The automatic transmission increases the traction motor torque and transfers it to the rear axle, with a maximum torque output of 2,237 Nm.

H2 Storage Tanks

6

Located behind the main cab

Emergency Procedures

Immobilise

Block wheels and set the parking brake.

1. Pull down the P (Park) lever to select the P (Park) position
2. Select the N (Neutral) lever to put the truck into neutral

1

2

Lifting points:

Appropriate lifting points

High voltage battery

Picture from underneath

Emergency Procedures

Disable Direct Hazards

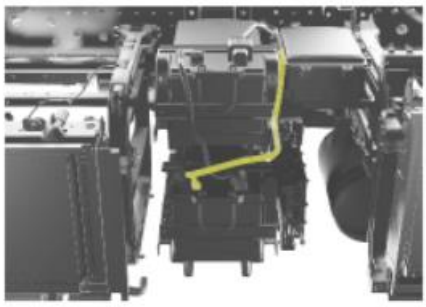
How to deactivate the high voltage system, when the vehicle is ON

Method 1: When the 'Ready' indicator in the instrument cluster is illuminated, press the Start/Stop button and disconnect the 24V Battery.

1

2

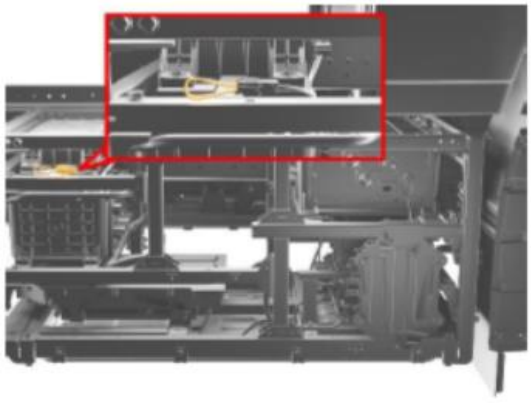
3



Method 2: Only use when 'method 1' is not accessible.

To disable, cut the indicated cable that is located at the right side of the vehicle.

Disconnect the 24V Battery located at the left side of the vehicle.



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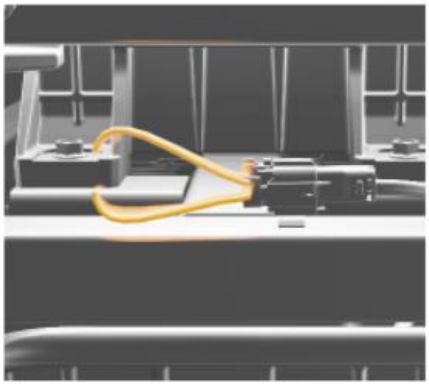

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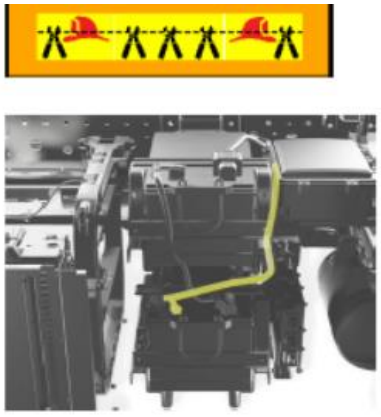
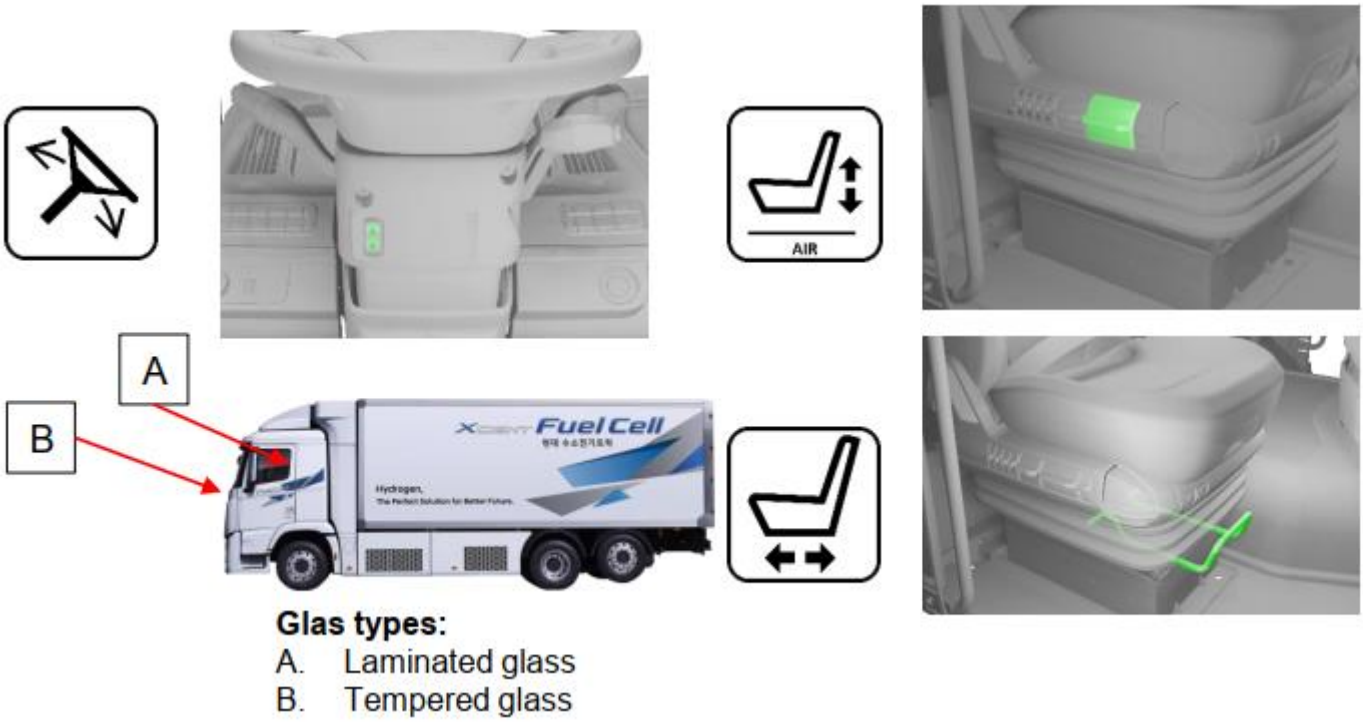


Emergency Procedures

Access To occupants



Type	Identification	Content	
NMC		Lithium Ion Nickel Manganese Cobalt Oxide	630 Volt
		24V Battery	24 Volt
H_2		Compressed Hydrogen tank	350 bar and 32.94kg of Hydrogen (Usable)

When conventional coolant leaks (check reservoir) from the high voltage (HV) battery cooling system, HV-battery can become unstable with risk of thermal runaway. An increasing HV-battery temperature might be an indicator of thermal runaway.

IR

	Height control truck, by air system		Risk of flammability
	Warning high voltage		Risk of damaging human health
	Caution		Risk of acute toxicity
	High voltage		Explosive
	Vehicle on hydrogen fuel cell electric vehicle		Risk of corrosive material / substances
	Use water to extinguish the fire		Seat height adjustment. by air system
	Use IR Camera (thermal imaging)		Seat adjustment, longitudinal
	Steering wheel, tilt control		Attention; hydrogen burns with an almost invisible flame

Emergency Procedures

Vehicle Fire

After Initial Emergency Response Procedures have been applied, firefighting procedures may begin. Hyundai recommends that each response team follow their own department's standard operating procedures for fighting vehicle fires in combination with the XCIENT specific details that are covered in this section.

Firefighting Operations

If the high-voltage battery pack is either involved in or at risk of being involved in a fire in a XCIENT, strict cautions must be taken while conducting firefighting operations due to following reasons:

- Lithium-ion polymer batteries contain gel electrolytes that can vent, ignite, and produce sparks when subjected to temperatures above 150°C.
- May burn rapidly with a flare-burning effect.
- Even after the high-voltage battery fire appears to have been extinguished, renewed or delayed fires can occur.
  - Use a thermal imaging camera to ensure the high voltage battery is completely cooled before leaving the incident.
  - Always advise second responders that there is a risk of the battery re-igniting.
  - If there is a fire, submersion or collision that has compromised the high voltage battery, always store it in an open area with no exposures within 50 feet.
- A burning battery could release hydrogen fluoride, carbon monoxide, and carbon dioxide gasses. Use NIOSH/MSHA approved full-face self-contained breathing apparatus (SCBA) with full protective gear.
- If the fire spreads to the hydrogen tanks at rear floor of XCIENT, you should not extinguish the fire. Find a place where you can protect yourself & others and wait until the vehicle is done burning.

Even if the high-voltage battery pack is not directly involved in a vehicle fire, approach the vehicle very carefully.

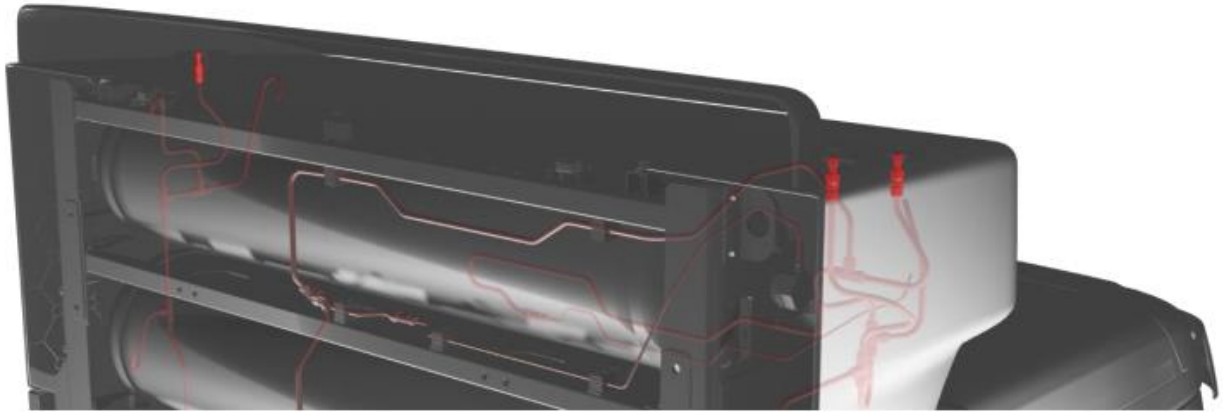
Emergency Procedures

USE LARGE AMOUNTS OF PURE WATER

POTENTIAL RISK OF BATTERY RE-IGNITION / DELAYED IGNITION!

Temperature **P**ressure **R**elease **D**evice **(TPRD)** opens at the 110℃ (loud hissing noise).
In the event of the fire, hydrogen will be released directly from the hydrogen tank. You may hear a hissing or a roaring sound as the hydrogen escapes, and it can take up to 35 minutes for a full tank to empty.

Stay clear of the vent location as indicated by the red lines.
Avoid cutting into the hydrogen pressurized line (Both Vent and Processing line)



Deactivate hydrogen flow.

To deactivate hydrogen supply from each tank to the stacks, turn the manual valve located at the left side of the vehicle to the right. It's recommended closing all 7 tank valves for safety purpose, even though the solenoid valves are close in case of fire.

Emergency Procedures

High-Voltage Battery Damage and Fluid Leaks

The high voltage battery assembly is enclosed in a sturdy metal case that is rigidly mounted to the structural components of the vehicle. This construction helps prevent damage to the high voltage battery assembly, even in severe crashes. This section provides emergency responders with information on how to mitigate the severity of a damaged high voltage battery assembly or a rare gel electrolyte spill.

- Stop all smoke, spark and flame activity around the vehicle.
- The electrolyte solution is a skin irritant.
- Do not touch or step on the spilled electrolyte.
- If an electrolyte leak occurs, wear appropriate solvent resistant PPE and use oil, sand, or a dry cloth to clean up the spilled electrolyte. Be sure to adequately ventilate the area.

⚠ WARNING Irritant Substance Risk !

- The internal components of high voltage batteries are irritants and sensitizers.
- To avoid contact with these irritants and sensitizers, wear positive pressure self-contained breathing apparatus (SCBA) and other personal protective equipment (PPE) designed for use with these types of hazards.

Failure to wear proper SCBA and PPE can result in serious injury or death

- The electrolyte solution is an eye irritant – If there is any contact with the eyes, rinse with plenty of water for 15 minutes.
- The electrolyte solution is also a skin irritant. If there is any contact with the skin, wash off with soap and water.
- Electrolyte liquid or fumes that have come into contact with water vapors in the air will create an oxidized substance. This substance may irritate the skin and eyes. In these cases, rinse with plenty of water and see a doctor immediately.
- Electrolyte fumes (when inhaled) can cause respiratory irritation and acute intoxication.

Move to a well ventilated location for fresh air and wash the mouth with water. See a doctor immediately.

Roadside Assistance

Towing

Towing the XCIENT is the same as towing other HT type vehicles with a diesel engine. If emergency towing is necessary, we recommend having it done by an authorised HYUNDAI Truck dealer or a commercial tow-truck service. Proper lifting and towing procedures are necessary to prevent damage to the truck. The best way to tow the truck is to lift the entire onto a flat bed tow truck.

However, if a flat bed tow truck is not available, then lock steering wheel, lift rear axles. Or if towing by lifting the front axle, then drive shaft assembly will need to be

Towing

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