TOYOTA

FCHV-adv

FUEL CELL HYBRID VEHICLE – ADVANCED

2009 Model

Emergency Response Guide

09 FCHV ERG Rev – for latest version consult **http://techinfo.toyota.com**

Forward

This guide provides emergency response information on the 2009 Toyota Fuel Cell Hybrid Vehicle- Advanced (FCHV-adv). The FCHV-adv is the next generation of Toyota Fuel Cell Hybrid Vehicles first introduced in limited numbers from 2002. The vehicle is based on a modified version of the 2001-2007 Toyota Highlander and is available in limited number for select US cities.

The purpose of this guide is to educate and assist emergency responders in the safe handling of the Toyota FCHV-adv following an incident. FCHV-adv emergency response procedures are similar to other Toyota vehicles with the exception of the hydrogen gas fuel cell system and the high voltage electrical system.

Unlike a conventional gasoline powered vehicle, the FCHV-adv uses:

- 10,000 psi (70 MPa) hydrogen gas storage tanks
- Compressed hydrogen gas in distribution lines, regulators, and fuel cell system components
- 400-Volt DC fuel cell generator
- 274-Volt DC Nickel Metal Hydride (NiMH) Hybrid Vehicle (HV) battery pack - similar to the one used in the Toyota Prius hybrid vehicle
- High voltage power cables, power control unit, and electric motor

Hydrogen is a colorless, odorless, flammable gas stored inside carbon fiber reinforced tanks located at the rear of the vehicle. The hydrogen gas from the tanks is distributed in a closed system to the fuel cell in the motor compartment through stainless steel distribution lines under the vehicle.

High voltage electricity is generated in the fuel cell by electrochemically combining the hydrogen gas with oxygen from the air. The byproducts of this reaction are water and heat. The heat is partially absorbed by the onboard cooling system and the balance is exhausted along with the water through the tailpipe. The FCHV-adv is a zero emissions vehicle.

High voltage electricity provided by either the fuel cell or the HV battery pack powers the vehicle by an electric motor. With the exception of the HV battery pack, all components containing hydrogen gas or high voltage are located outside the vehicle's cabin under the floor pan or in the motor compartment under the hood for safety.

The HV battery pack is contained in a metal case and bolted to the frame cross member inside the vehicle, below the rear cargo area cover. The NiMH HV battery pack contains sealed batteries that are similar to rechargeable batteries used in laptop computers, cell phones, and other consumer products. The electrolyte is absorbed in the cell plates and will not normally leak out even if the battery is cracked. All other conventional automotive electrical devices such as the headlights, radio, and airbags are powered from a separate lead-acid 12-Volt battery.

Hydrogen gas and high voltage electrical safety remains an important factor in the emergency handling of the FCHV-adv. It is important to recognize and understand the features and specifications of these systems provided in this guide, as they may not be familiar to emergency responders.

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FCHV Identification

Exterior

In appearance, the FCHV-adv is similar to the previous FCHV and is based on a modified 2001-2007 Toyota Highlander. As shown in the pictures, the FCHV-adv may be identified by the graphic identifiers along the middle and portions of the vehicle body. Two distinguishing marks are the ***FCHV-adv*** graphic located on the hood near the grill area, the right side of the back door, and on the left and right rear doors. The other mark is the **70 MPa** graphic on both rear quarter panels which stands for the 10,000 psi hydrogen gas storage pressure inside the tanks.

The FCHV-adv may also be differentiated from a Toyota Highlander by noting the revised front grill and bumper, the rear spoiler design, the black covers under the rear and sides of the FCHV-adv, and the tail pipe.

FCHV Identification (Continued)

Exterior (Continued)

Interior

As indicated in the photos, the vehicle interior appears similar to the 2001-2007 Toyota Highlander. ***FCHV-adv*** badges in the interior may be used to identify the vehicle.

FCHV Identification (Continued)

Motor Compartment

The motor compartment contains the Power Control Unit with the FCHV-adv logo and a fuel cell and battery location information label.

Component Locations & Descriptions

Hydrogen Gas Components

Component	Location	Description
Fuel Cell	Motor compartment	Utilizes hydrogen gas and oxygen from the air to generate high voltage DC electricity.
Hydrogen Storage Tanks	Underneath rear of vehicle	Four tanks store compressed hydrogen gas at up to 10,000 psi (70 MPa).
Tank Shut Valve	Mounted on the driver side of each hydrogen storage tank	Shuts off hydrogen flow from each tank with normally closed (no hydrogen flow) solenoid.
Temperature Relief Device (TRD)	Mounted on the tank shut valve	Fusible temperature plug that quickly vents hydrogen gas in the tank outside the vehicle as a safety measure if the plug temperature exceeds 230 ^{o}F (110 ^{o}C).
Hydrogen Lines	Motor compartment, underneath vehicle floor pan running inboard of driver side frame rail, and between the fuel filler and the tanks	Red colored stainless steel lines carry pressurized hydrogen gas.
Hydrogen Fuel Filler	Inside fuel filler door at driver side rear quarter panel	Inlet coupling receptacle for fueling hydrogen gas.

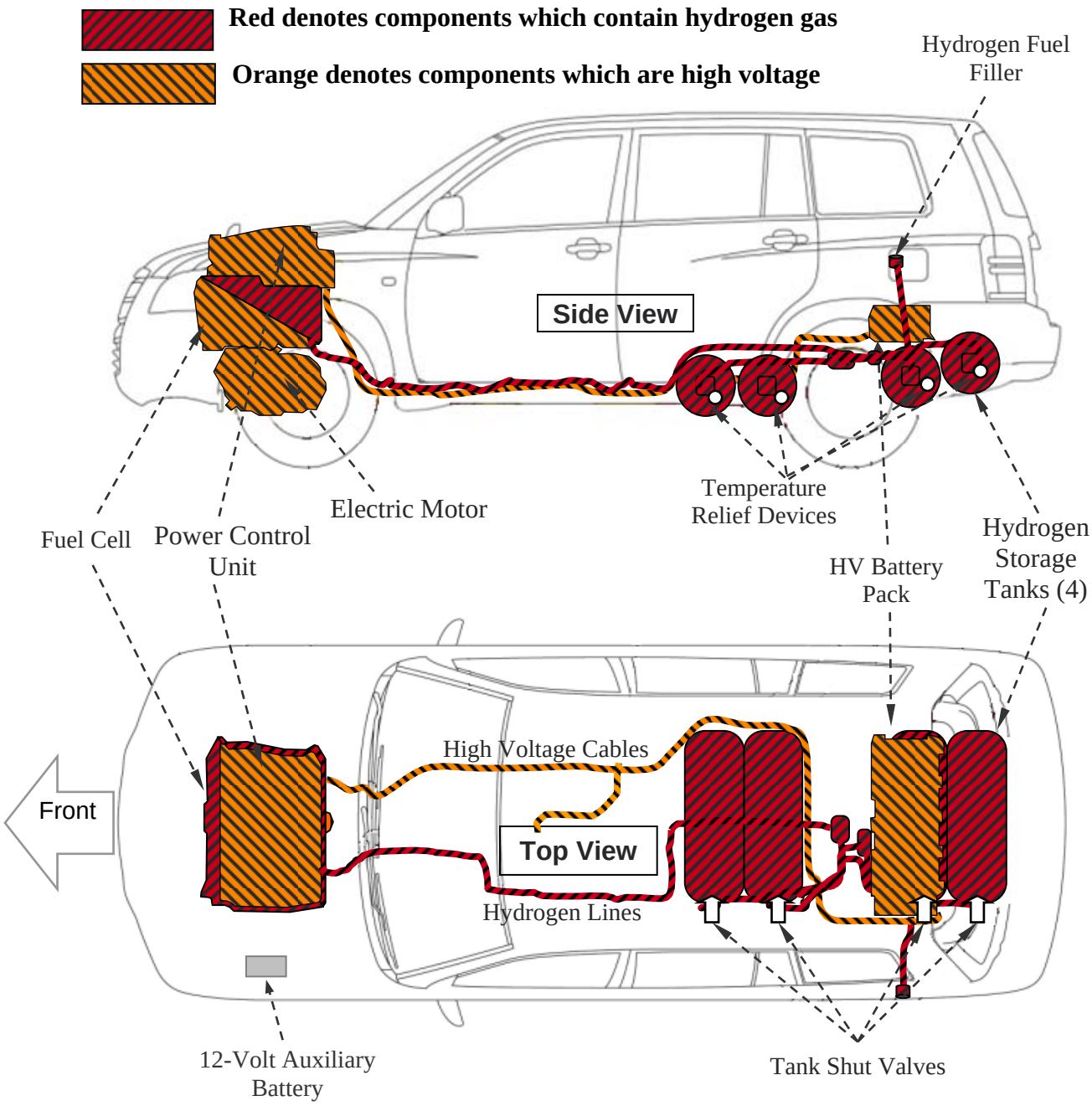
High Voltage Components

Component	Location	Description
Fuel Cell	Motor compartment	Utilizes hydrogen gas and oxygen from the air to generate high voltage DC electricity.
Hybrid Vehicle (HV) Battery Pack	Cargo area affixed to lateral cross member	274-Volt Nickel Metal Hydride (NiMH) battery pack consisting of battery modules connected in series.
Power Control Unit (PCU)	Motor compartment	Converts DC current from Fuel Cell and HV battery pack to 3 phase AC that drives high voltage electric motors/components. Also, converts AC from electric motor (regenerative braking) to DC to recharge the HV battery pack.
Electric Motor	Motor compartment	3 Phase AC permanent magnet electric motor contained in the transaxle. Driven by the PCU and used to power the vehicle. Generates electric current during “coasting” or braking.
Fuel Cell Air Compressor	Motor compartment	Pumps air to the fuel cell. Driven by the PCU using 3 Phase AC.
Fuel Cell Water Pump	Motor compartment	Circulates coolant between the fuel cell, hydrogen pump and radiators.
Air Conditioning (A/C) Compressor	Motor compartment	Circulates Carbon Dioxide (CO_2) refrigerant through the air conditioning system.
High Voltage Cables	Motor compartment and underneath vehicle floor pan running inboard of right frame rail and at HV battery	Orange colored power cables carry high voltage DC current between the PCU and the fuel cell and between the PCU and the HV battery pack. Other orange colored cables carry 3 phase AC current between PCU and components in the motor compartment.

Component Locations & Descriptions (Continued)

Other Components

Component	Location	Description
12-Volt Auxiliary Battery	Motor compartment	Low voltage lead-acid battery that powers all electrical equipment except high-voltage motors and pumps.



Note: The orange and red color coding is for an illustrative purpose. Only the orange high voltage cabling and the red hydrogen lines are colored in the vehicle. Although not shown in the illustration, the Fuel Cell Water Pump, Fuel Cell Air Pump, and the A/C Compressor are components located in the motor compartment. These components operate with high voltage electricity.

Vehicle Specifications

Toyota FCHV-adv		
Vehicle	Electric Motor	120 Hp (90 KW)
	Transmission	Direct Drive Automatic
	HV Battery	274 Volt Sealed NiMH
	Fuel Cell	90 kW
	Hydrogen Tanks	10,000 psi (70MPa)
	Tank Capacity	41 gal (156 L)
	Seating Capacity	5 Passenger
	Length	186 in (4,735 mm)
	Width	71 in (1,815mm)
	Height	66 in (1,685 mm)
	Weight	4,145 lbs (1,880 kg)
Frame Material	Steel unibody with aluminum hood, front fenders, and doors	--
Performance	Maximum range (cruising) 10-15 test cycle	515 mi (830 km)
	Maximum speed	96 mph (155 km/h)

FCHV-adv Operation

The vehicle starts and becomes operational by turning the ignition key to "START" just like any other typical automobile. However, the fuel cell operation is basically silent. It is important to recognize and understand the **READY** indicator provided in the instrument cluster. When lit, it informs the driver the vehicle is on and operational.

Never assume the vehicle is shut off just because the motor compartment is silent. Always look for the **READY** indicator status.

Vehicle Operation

- Whenever the **READY** indicator is on:
  1. Pressurized hydrogen gas will flow through the hydrogen gas components.
  2. High voltage electricity will flow through the high voltage components.

- Whenever the **READY** indicator is off, such as when the ignition key is turned off, the hydrogen and high voltage systems will be disabled as follows:
  1. Normally closed 12 Volt tank shut valves will turn off (default position for safety) to stop the flow of hydrogen and isolate the hydrogen to inside the storage tanks.
  2. Normally open 12 Volt relays will open (default position for safety) to stop the flow of high voltage electricity and isolate the high voltage potential to inside the fuel cell case and HV battery case.

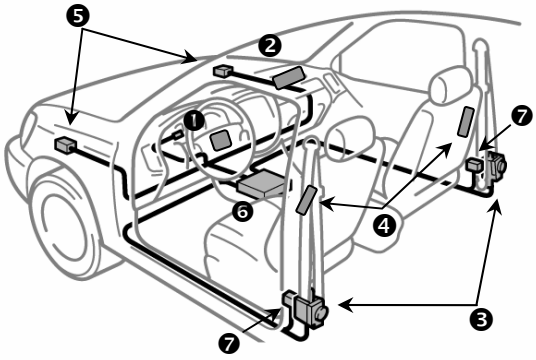
Airbags and Seat Belt Pretensioners

The FCHV includes as standard equipment driver and passenger front airbags and front seatbelt pretensioners. Side airbags are also included in the front seats. Design and operation is similar to that of the 2001-2007 Toyota Highlander.

> ⚠ **WARNING:**
> *The SRS may remain powered for up to 90 seconds after the vehicle is shut off (**READY** indicator off) or disabled. To prevent serious injury or death from unintentional SRS deployment, avoid breaching the SRS components.*

Airbag and Sensor Locations

Component	Location
Driver front airbag	In steering wheel horn button (pad) ❶.
Passenger front air bag	In upper dash pad on passenger side ❷.
Seat belt pretensioner	Inside the driver side seat belt retractor at the lower B-pillar ❸.
Seat belt pretensioner	Inside the passenger side seat belt retractor at the lower B-pillar ❸.
Side impact airbag	On the lower side of the driver seat seatback facing the door ❹.
Side impact airbag	On the lower side of the passenger seat seatback facing the door ❹.
Front airbag sensors (2)	Front section of the motor compartment ❺
SRS computer and airbag sensor	Mounted on the floor pan near the center console ❻
Side impact airbag sensor	Mounted in the lower driver side and B-pillar ❼.
Side impact airbag sensor	Mounted in the lower passenger side and B-pillar ❼



Standard Frontal Airbags and Seat Belt Pretensioners

Hydrogen Safety

Hydrogen Properties

Instead of using gasoline, the FCHV-adv uses hydrogen gas as the fuel source. Hydrogen is a colorless, odorless, non-toxic, flammable gas. Inside the fuel cell, hydrogen gas is consumed in an electrochemical reaction and is not burned.

Burning hydrogen requires an ignition source and concentration in air between 4% and 74% by volume. However, it is difficult to capture hydrogen due to its lighter than air properties, about 14 times lighter than air, when released into the atmosphere. Unlike gasoline which tends to pool near the ground, hydrogen rapidly disperses upward and dissipates. As with all flammable gases, confined hydrogen within its flammability range could result in an explosive mixture if ignited.

Hydrogen can ignite with low ignition energy, especially at higher concentrations. Therefore, it's important to keep ignition sources such as electric motors and static electricity away from hydrogen leaks. Burning hydrogen produces a faint blue flame that is difficult to see, especially in sunlight, and almost no radiant heat. Other organic material consumed in the fire may be detected, but it is possible to approach burning hydrogen, not see the flame and feel no heat. A UV optical detector/sensor may be used to aid in detection of a hydrogen fire.

As with most gases, asphyxiation may be possible if hydrogen displaces air in confined spaces.

Hydrogen Safety System

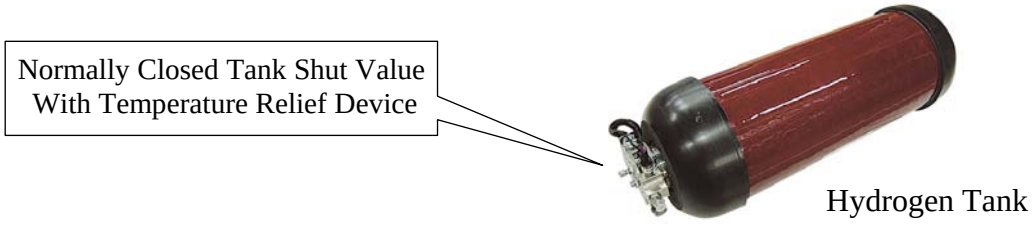
The FCHV-adv has a number of safety systems designed into the vehicle to prevent hydrogen hazards. The system is designed to prevent hydrogen leakage. If a leak is detected, the system is designed to stop hydrogen flow preventing an accumulation of hydrogen within the flammability range.

Hydrogen at pressures up to 10,000 psi is stored in the tanks. These tanks are much stronger than typical gasoline fuel tanks and are design to withstand 2.25 times the operating pressure. They are made from a polymer liner and wrapped with carbon fiber to meet Hydrogen Gas Vehicle standards. When the vehicle is shut off, hydrogen is contained within the tank through a normally closed solenoid operated shut valve preventing any flow of hydrogen outside the tank.

Hydrogen tanks, when opened, supply gas through distribution lines ❶ and pressure regulators to the fuel cell. Pressure regulation provides much lower than tank pressure inside the distribution lines. The distribution lines and regulators are pressure rated at least 1.5 times operating pressure, and are located inboard of the driver frame rail for protection and under the vehicle floor pan routed outside of the vehicle to prevent hydrogen accumulation inside the cabin should a leak occur.

One-way check valves are employed at the inlet lines of each hydrogen storage tank❷, at the hydrogen fuel filler ❸ and at locations in the hydrogen distribution lines to prevent leaks.

Temperature Relief Devices (TRD's) ❹ quickly vent hydrogen to the atmosphere when the temperature reaches 230 ^{o}F to prevent excessive pressure in the tanks. The venting ports are located on the lower driver side of each hydrogen storage tank. Typically a loud hissing noise will be heard for a few minutes when the tanks vent and a high pressure stream of hydrogen gas will be vented.



Hydrogen Tank

Hydrogen Safety (Continued)

Hydrogen Safety System (Continued)

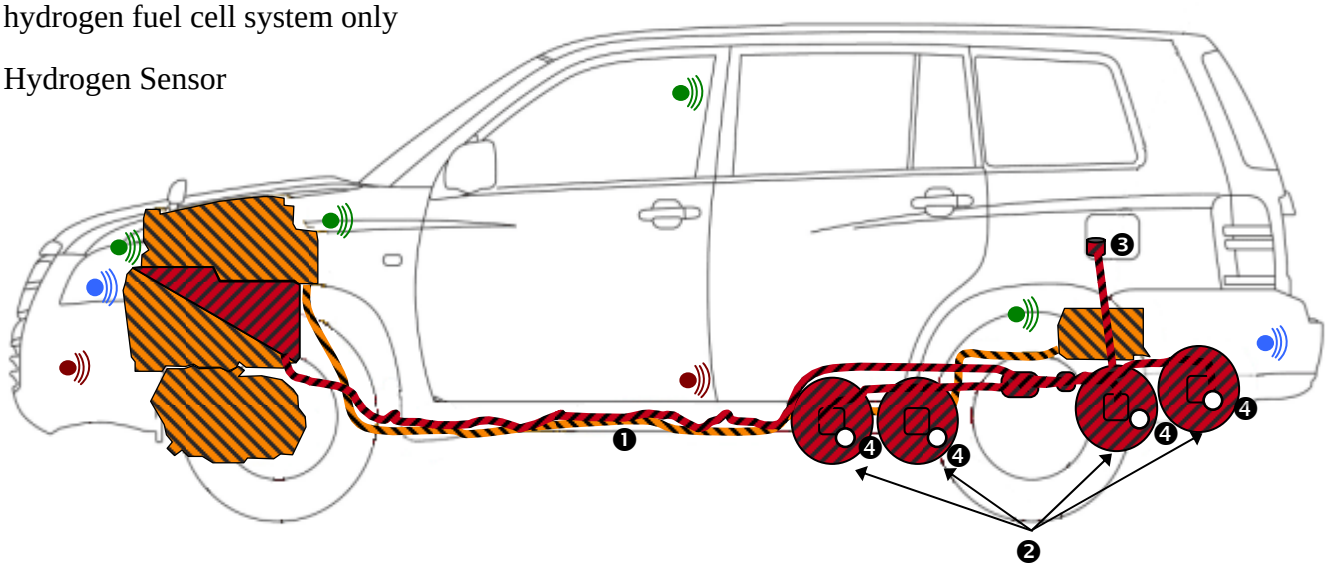
The FCHV-adv control unit monitors system pressures along the hydrogen fuel cell system while the vehicle is on. The vehicle's control unit closes tank shut valves to stop the outlet flow of hydrogen gas at each of the four tanks when:

1. The vehicle is off (**READY** indicator off).
2. An abnormal pressure loss (leak) or pressure increase (regulator/valve malfunction) is detected.
3. Frontal or side airbag impact sensors cause an airbag to deploy.
4. Motor compartment or rear impact sensors for the fuel cell system sense an impact.
5. Any of four hydrogen sensors mounted on board the vehicle detects hydrogen gas accumulation. The control unit will also illuminate the "H2" warning light in the instrument cluster ❺ and sound a buzzer to warn the driver.
6. The hood or fuel door is opened.
7. A malfunction is detected with a tank shut valve.

Impact (Collision) Sensor for Airbags and fuel cell system

Impact (Collision) Sensor for the hydrogen fuel cell system only

Hydrogen Sensor



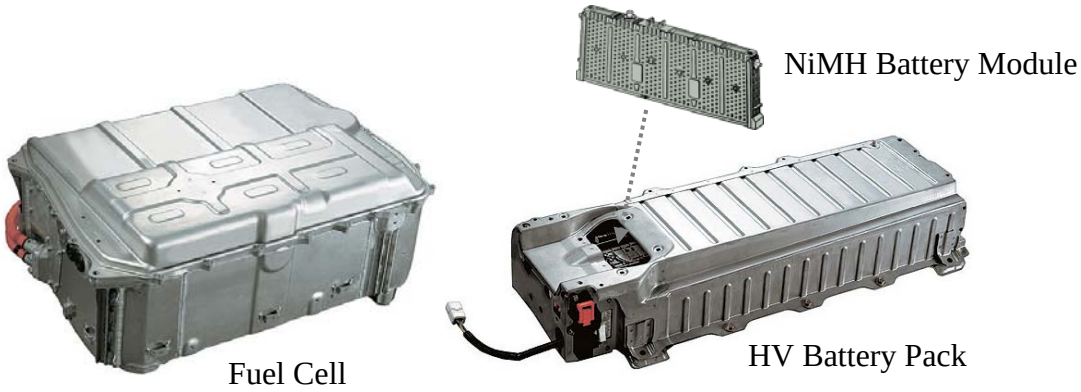
⚠WARNING:

- *Hydrogen gas remains in the fuel cell system after the vehicle is shut off (**READY** indicator is off) or disabled. Do not operate electrical or extricating equipment that may create a spark if hydrogen is leaking (hissing is heard).*
- *To prevent serious injury or death from fire or explosion, avoid cutting or breaching hydrogen components.*

High Voltage Safety

The FCHV-adv contains a fuel cell generator and a high voltage battery pack as its two sources of high voltage electricity. Orange high voltage power cables distribute electricity between these two power sources and the system of motors, pumps, and compressors that operate from them.

The fuel cell operates by electrochemically combining hydrogen gas with oxygen from the air and is the main source of high voltage electricity. The fuel cell is sealed in a metal case and electrically insulated from the vehicle's metal body in the motor compartment. Inside the case is a group of proton exchange membrane electrode assemblies. These assemblies generate high voltage electricity up to 400 Volts DC.



The HV battery pack contains 38 low voltage 7.2 Volt sealed, non-spillable Nickel Metal Hydride (NiMH) battery modules connected in series to produce approximately 274 Volts. Similar to the fuel cell, the HV battery pack is sealed in a metal case and electrically insulated from the vehicle's metal body. It is mounted to the rear frame cross member under the cargo area, concealed by fabric and plastic covers. The electrolyte used in the NiMH battery module is an alkaline of potassium and sodium hydroxide that is absorbed into the battery cell plates and will not normally leak, even in a collision.

HV Battery Pack Specifications	
Battery pack voltage	274-Volts
Number of NiMH battery modules in the pack	38
Battery pack weight	100 lbs
NiMH battery module voltage	7.2-Volts
NiMH battery module dimensions (inches)	11 x 3/4 x 4
NiMH Battery module weight	2.2 lbs

The FCHV-adv has a number of safety systems designed into the vehicle to prevent high voltage hazards. The system is designed to insulate all high voltage components including the fuel cell, HV battery pack, and power cables from the vehicle's metal body. No high voltage electricity flows through the metal body of the vehicle. Instead of using the metal body as a ground, separate positive and negative, orange colored for identification, power cables are routed between high voltage components. These power cables are routed outside the vehicle, under the floor pan, and inboard of the passenger side frame rail between the motor compartment and rear cargo area. Additional cabling is routed inside the motor compartment.

Occupants and emergency responders touching the metal vehicle body are not in contact with the high voltage circuit. If there is a loss of insulation, the system is designed to stop the flow of high voltage electricity and isolate the high voltage to the fuel cell and HV battery pack.

High Voltage Safety (Continued)

The fuel cell and the HV battery pack high voltage electrical output is controlled by normally open 12 Volt relays. When the vehicle is shut off, the relays stop electrical flow from both the fuel cell and the HV battery pack which de-energizes the orange high voltage power cables. However, high voltage potential remains within the fuel cell case and within the HV battery pack case.

The FCHV-adv control unit monitors the fuel cell, HV battery pack, and current and voltage along the high voltage system while the vehicle is on. The vehicle's control unit will open the fuel cell and HV battery pack relays to stop high voltage electrical flow when:

1. The vehicle is off (**READY** indicator off).
2. A malfunction is detected in the fuel cell or HV battery pack.
3. An abnormal voltage or current is detected.
4. Frontal or side airbag impact sensors cause an airbag to deploy.
5. Motor compartment or rear impact sensors for the fuel cell system sense an impact.
6. The hood or fuel filler door is opened.

⚠ **WARNING:**
*The high voltage system may remain powered for up to 5 minutes after the vehicle is shut off (**READY** indicator off) or disabled. To prevent serious injury or death from severe burns or electric shock, avoid touching, cutting, or breaching any orange high voltage power cable or high voltage component.*

Emergency Response

On arrival, emergency responders should follow their standard operating procedures for vehicle incidents. Emergencies involving the FCHV-adv may be handled like other automobiles except as noted in these guidelines for Extrication, Fire, Overhaul, Recovery, Spills, First Aid, and Submersion.

⚠ WARNING:

- ***Never** assume the FCHV-adv is shut off simply because it is silent.*
- *Always observe the instrument cluster for the **READY** indicator status to verify whether the vehicle is on or shut off. The vehicle is shut off when the **READY** indicator is off.*
- *Failure to shut off the vehicle before emergency response procedures are performed may result in serious injury or death from the unintentional deployment of the SRS, severe burns and electric shock from the high voltage electrical system, and fire or explosion from the hydrogen fuel cell system.*

<u>Extrication</u>

- Immobilize Vehicle

  Chock wheels and set the parking brake (parking brake pedal located left of brake pedal).
  Move the shift lever to the **P** (park) position.

- Disable Vehicle

  Procedure #1

  1. Turn the ignition key to the "OFF" position, remove the ignition key and place on dash.
  2. Disconnect the negative cable of the 12-Volt auxiliary battery as shown in Photo A on page 14.

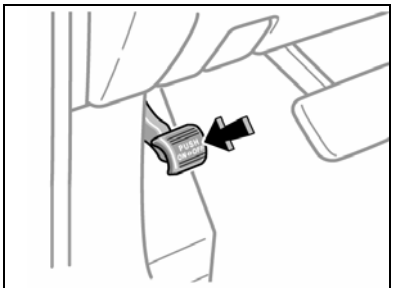
  Procedure #2 (alternate if ignition key is inaccessible)

  1. Disconnect the negative cable of the 12-Volt auxiliary battery as shown in Photo A on page 14.
  2. Remove the IGCT No 1 and IGCTFC fuses in the engine compartment as shown in Photo B on page 14.

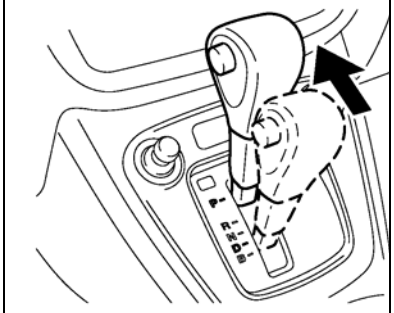
  Performing either of the disabling procedures above has the following effects on the hydrogen and high voltage systems:

  - Tank shut valves will close and stop hydrogen gas flow at each of the four hydrogen storage tanks.
  - Relays will open and stop high voltage electrical flow from the fuel cell and HV battery pack.
  - SRS airbags and seat belt pretensioners are disabled.

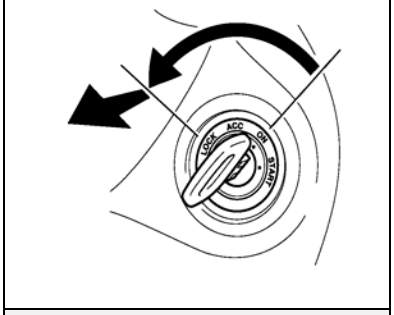
  NOTE:
  Before disconnecting the 12 Volt auxiliary battery, if necessary, reposition the power seat, lower the windows, unlock the doors. Once the 12 Volt auxiliary battery is disconnected, power controls will not operate.



Set Parking Brake



Shift Lever in Park



Turn Ignition Key Off, Remove Key

Emergency Response (Continued)

Extrication (Continued)

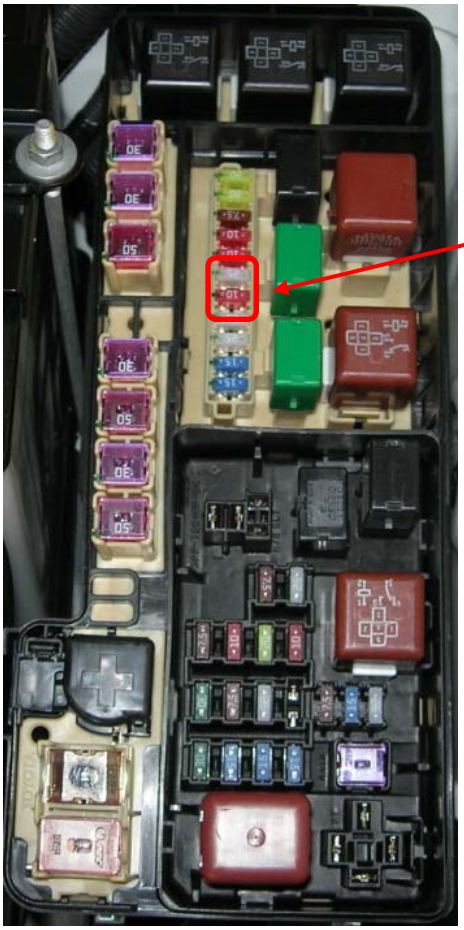
Disconnecting the 12-Volt battery:
The battery is located on the driver side motor compartment.

Removing the IGCT No 1 and IGCTFC fuses:
Remove the red colored IGCT fuse (10A) and the white colored IGCTFC (25A) fuse from the motor compartment fuse box as shown in Photo B. If the correct fuses cannot be recognized, pull all fuses in the fuse box.

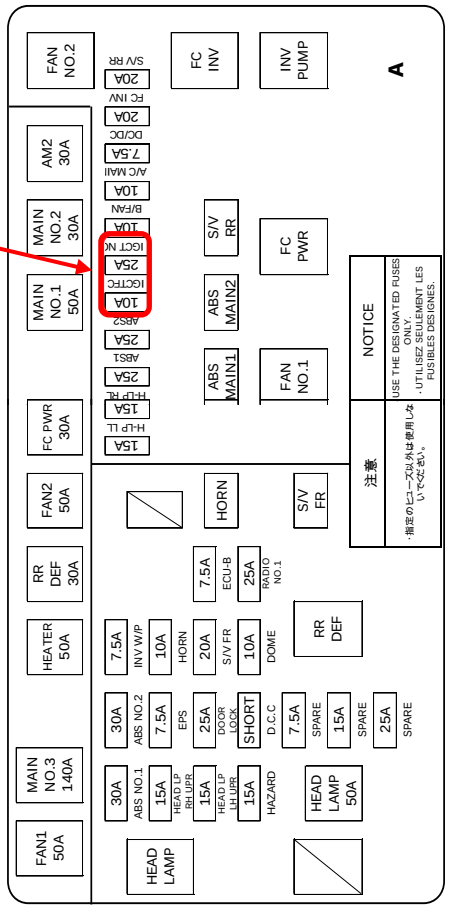
Photo A: 12 Volt Auxiliary Battery

Photo B: Fuse Box Location

Fuse Removal Tool



Fuses:
IGCT No 1 (10A) Red
IGCTFC (25A) White



Emergency Response (Continued)

Extrication (Continued)

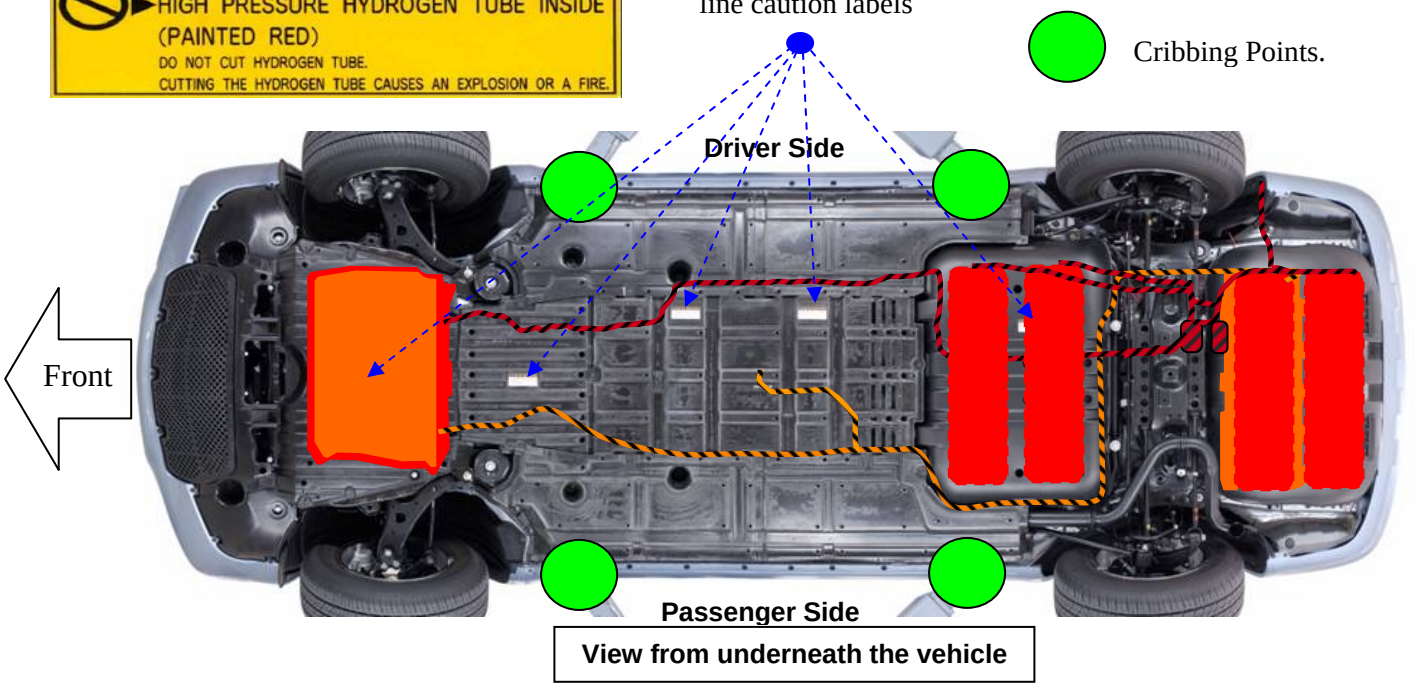
⚠WARNING:

- *The high voltage system may remain powered for up to 5 minutes after the vehicle is shut off (**READY** indicator off) or disabled. To prevent serious injury or death from severe burns or electric shock, avoid touching, cutting, or breaching any orange high voltage power cable or high voltage component.*
- *Hydrogen gas remains in the fuel cell system after the vehicle is shut off (**READY** indicator is off) or disabled. To prevent serious injury or death from fire or explosion, avoid cutting or breaching hydrogen components, and do not operate electrical or extricating equipment that may create sparks if hydrogen is leaking (hissing is heard).*
- *The SRS may remain powered for up to 90 seconds after the vehicle is shut off or disabled. To prevent serious injury or death from unintentional SRS deployment, avoid breaching the SRS components.*
- *If either of the disabling steps cannot be performed, proceed with caution as there is no assurance that the hydrogen system, high voltage electrical system, or the SRS airbag system are disabled.*

- Stabilize Vehicle

  Crib at (4) points directly under the front and rear pillars. Do not place cribbing under the hydrogen lines, hydrogen storage tanks or the high voltage power cables and related components.

  The under vehicle illustration below shows locations for the recommended cribbing points. Labels for hydrogen gas line locations are attached to the underbody covers. Red indicates the location of components containing hydrogen gas. Orange indicates location of components operating with high voltage.



Emergency Response (Continued)

Extrication (Continued)

- Access Patients

  Glass Removal

  Use normal glass removal procedures as required.

  SRS Awareness

  Responders need to be cautious when working in close proximity to undeployed airbags and seat belt pretensioners. Front dual stage airbags automatically ignite both stages within a fraction of a second.

  Door Removal/Displacement

  Doors can be removed by conventional rescue tools - hand, electric, and hydraulic. No hydrogen or high voltage lines are routed in the doors. In certain situations, it may be easier to pry back the body to expose and unbolt the hinges.

  Dash Displacement

  Displace the dash by using a conventional dash roll, modified dash roll, or jacking the dash.

  Roof Removal

  The roof may be removed as there are no SRS airbag devices above the door line.

  Rescue Lift Air Bags

  Responders should not place rescue lift airbags under the hydrogen lines, hydrogen storage tanks, or high voltage power cables.

Fire

Approach and extinguish a fire using proper vehicle fire fighting practices as recommended by NFPA, IFSTA, or the National Fire Academy (USA).

- Extinguishing Agent

  Water has been proven to be a suitable extinguishing agent.

- Initial Fire Attack

  Perform a fast, aggressive fire attack.
  Divert the runoff from entering watershed areas.
  Attack teams may not be able to identify an FCHV until the fire has been knocked down and overhaul operations have commenced.

- Fire Fed by Hydrogen Gas

  Each hydrogen storage tank is fitted with a Temperature Relief Device (TRD). When the temperature around the TRD reaches 230 ºF, hydrogen is quickly released to prevent excessive pressure in the tanks. The release of hydrogen gas from a TRD can be identified by the loud “hissing” sound and a high pressure stream of hydrogen gas.

  This release of hydrogen can ignite in a concentrated flame stream. The venting emanates from the tank valve mechanism located at the rear driver side, under the vehicle.

Emergency Response (Continued)

Fire (Continued)

If the hydrogen gas has ignited, the fire attack crew should pull back to a safe distance and allow the hydrogen gas fed fire to burn until the hydrogen feeding the fire completely vents to atmosphere. During this time, crews may utilize a water stream or fog pattern to protect exposures or to control the path of smoke, taking care not to extinguish hydrogen-fed flames. If flames from the hydrogen gas fire are extinguished, hydrogen gas may accumulate resulting in a risk of explosive reignition.

- Fire in the HV Battery Pack

  Should a fire occur in the NiMH HV battery pack, attack crews should utilize a water stream or fog pattern to extinguish any fire within the vehicle *except* for the HV battery pack.

  When allowed to burn themselves out, the FCHV-adv NiMH battery modules burn rapidly and can quickly be reduced to ashes except for the metal.

  ⚠ **WARNING:**
  - *The NiMH battery electrolyte is a caustic alkaline (pH 13.5) that is damaging to human tissues. To avoid injury by coming in contact with the electrolyte, wear proper personal protective equipment.*
  - *The battery modules are contained within a metal case and accessibility is limited.*
  - *To avoid serious injury or death from severe burns or electric shock, **never** breach or remove the high voltage battery pack cover under any circumstance including fire.*

  Offensive Fire Attack

  Normally, flooding an NiMH HV battery pack with copious amounts of water at a safe distance will effectively control the HV battery pack fire by cooling the adjacent NiMH battery modules to a point below their ignition temperature. The remaining modules on fire, if not extinguished by the water, will burn themselves out.

  However, flooding the FCHV-adv battery pack is *not* recommended due to the battery case design and location preventing the responder from properly applying water through the available vent openings safely. Therefore, it is recommended that the incident commander allow the FCHV-adv HV battery pack to burn itself out.

  Defensive Fire Attack

  If the decision has been made to fight the fire using a defensive attack, the fire attack crew should pull back a safe distance and allow the NiMH battery modules to burn themselves out. During this defensive operation, fire crews may utilize a water stream or fog pattern to protect exposures or to control the path of smoke.

Overhaul

During overhaul, if not already done, immobilize and disable the vehicle. The HV battery pack should never be breached or removed under any circumstance including fire. Doing so may result in severe electrical burns, shock, or electrocution.

- Immobilize Vehicle

  Chock wheels and set the parking brake.

  Move the shift lever to the **P** (park) position.

Emergency Response (Continued)

Overhaul (Continued)

- Disable Vehicle

  Procedure #1

  1. Turn the ignition key to the "OFF" position, remove the ignition key and place on dash.
  2. Disconnect the negative cable of the 12-Volt auxiliary battery as shown in Photo A on page 14.

  Procedure #2 (alternate if ignition key is inaccessible)

  1. Disconnect the negative cable of the 12-Volt auxiliary battery as shown in Photo A on page 14.
  2. Remove the IGCT No 1 and IGCTFC fuses in the engine compartment as shown in Photo B on page 14.

  Performing either of the disabling procedures above has the following effects on the hydrogen and high voltage systems:

  - Tank shut valves will close and stop hydrogen gas flow at each of the four hydrogen storage tanks.
  - Relays will open and stop high voltage electrical flow from the fuel cell and HV battery pack.
  - SRS airbags and seat belt pretensioners will be disabled.

Recovery of the NiMH HV Battery Pack

Clean up of the HV battery pack can be accomplished by the vehicle recovery crew without further concern from runoff or spill.

Spills

The FCHV-adv contains the same common automotive fluids used in other Toyota vehicles, with the exception of the NiMH electrolyte used in HV battery pack. The NiMH battery electrolyte is a caustic alkaline (pH 13.5) that is damaging to human tissues. The electrolyte, however, is absorbed in the cell plates and will not normally spill or leak out even if a battery module is cracked. A catastrophic crash that would breach both the metal battery pack case and the plastic battery module would be a rare occurrence.

Similar to using baking soda to neutralize a lead-acid battery electrolyte spill, a dilute boric acid solution or vinegar is used to neutralize a NiMH battery electrolyte spill.

NOTE:
Electrolyte leakage from the HV battery pack is unlikely due to its construction and the amount of available electrolyte contained within the NiMH modules. Any spillage would not warrant a declaration as a hazardous material incident. Responders should follow the recommendations as outlined in this emergency response guide.

During an emergency, Material Safety Data Sheets (MSDS) may be requested by contacting CHEMTREC at (800) 424-9300.

- Handle NiMH Electrolyte Spills Using The Following Personal Protective Equipment (PPE):
  Splash shield or safety goggles. Fold down helmet shields are not acceptable for alkaline spills.
  Rubber, latex or Nitrile gloves.
  Apron suitable for alkaline.
  Rubber boots.

- Neutralize NiMH Electrolyte
  Use a boric acid solution or vinegar.
  Boric acid solution - 800 grams boric acid to 20 liters water or 5.5 ounces boric acid to 1 gallon of water.

Emergency Response (Continued)

First Aid

Emergency responders may not be familiar with a NiMH electrolyte exposure when rendering aid to a patient. Exposure to the electrolyte is unlikely except in a catastrophic crash or through improper handling. Utilize the following guidelines during an exposure.

⚠WARNING:
The NIMH battery electrolyte is a caustic alkaline (pH 13.5) that is damaging to human tissue. To avoid injury by coming in contact with the electrolyte, wear proper personal protective equipment.

- Wear Personal Protective Equipment (PPE)
  Splash shield or safety goggles. Fold down helmet shields are not acceptable for acid or alkaline spills.
  Rubber, latex or Nitrile gloves.
  Apron suitable for alkaline.
  Rubber boots.

- Absorption
  Perform gross decontamination by removing affected clothing and properly disposing of the garments.
  Rinse the affected areas with water for 20 minutes.
  Transport to the nearest emergency medical care facility.

- Inhalation Non-Fire Situations
  No toxic gases are emitted under normal conditions.

- Inhalation Fire Situations
  Toxic gases are given off as the by-product of combustion. All responders in the Hot Zone should wear the proper PPE for fire fighting including SCBA.
  Remove patient from the hazardous environment to a safe area and administer oxygen.
  Transport to the nearest emergency medical care facility.

- Ingestion
  Do not induce vomiting.
  Allow patient to drink large quantities of water to dilute electrolyte (Never give water to an unconscious person).
  If vomiting occurs spontaneously, keep patients head lowered and forward to reduce the risk of aspiration.
  Transport to the nearest emergency medical care facility.

Submersion

A submerged FCHV-adv does not have high voltage potential on the metal vehicle body and is safe to touch.

- Access Patients
  Responders can access the patient and perform normal extrication procedures. Hydrogen and high voltage components should never be touched, cut, or breached.

- Vehicle Recovery
  If a FCHV-adv is fully or partially submerged in water, emergency responders may not be able to determine if the vehicle has been automatically disabled. The FCHV-adv may be handled by following these recommendations:
  - Remove the vehicle from the water.
  - Drain the water from the vehicle if possible.
  - Follow the immobilizing and disabling procedures on page 13.

Roadside Assistance

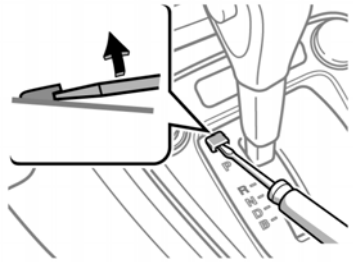
Emergency Roadside assistance is available by calling (866) 882-6411 - 24 hours a day, 7 days a week.

Towing

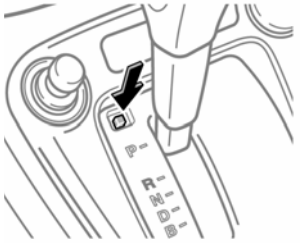
The FCHV-adv is a front wheel drive vehicle and has less ground clearance than conventional vehicles and must be towed on a flatbed tow truck. Take care to not damage the underbody covers or components when driving or winching the vehicle onto the flatbed.

- To shift the vehicle to neutral, turn the ignition switch to the "ON" position, press the brake pedal, and while pressing the shift lever button, move the lever to the **N** (neutral) position.
- If the shift lever cannot be moved out of **P** (park) with the above method, push and hold the shift lock release button and move the shift lever to **N** (neutral).
- The FCHV-adv shift lever includes a **B** position allowing regenerative braking while driving down a steep grade.
- If a tow truck is not available, in an emergency the vehicle may be moved using a cable or chain secured to the emergency towing eyelet. The eyelet is located under the rear cargo cover on the passenger side and is installed in the front bumper as illustrated. This should only be attempted on hard, paved roads for short distances at low speeds.

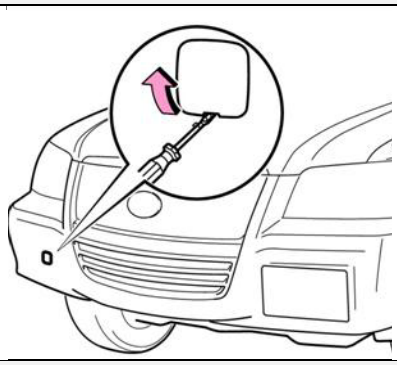
⚠WARNING:
Do not tow the vehicle with the front wheels on the ground as the motor may start generating electricity, depending on the vehicle's damage state, resulting in an electrical spark and fire hazard.



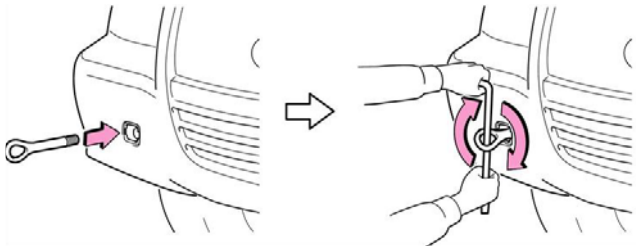
Shift Lock Release Button Cover



Push Button To Move Shift Lever From **P** (Park)



Eyelet Installation



Eyelet Installation

Roadside Assistance (Continued)

Spare Tire

A spare tire and jack are not provided with this vehicle. If a minor puncture is found in the tread area of the tire, utilize the tire repair kit located in the rear cargo compartment. Follow the instructions in the kit to repair the tire.

Vehicle Automatic Shut Off Modes

The FCHV is designed to automatically shut off the vehicle if the fuel filler door or hood is opened. To restart the vehicle, the fuel filler door and the hood must be closed.

Jump Starting

If one or more of the following symptoms occur, the 12-Volt auxiliary battery may be discharged.

- The instrument cluster gauges do not light when the ignition switch is turned to the "ON" position.
- The vehicle does not start (**READY** indicator does not come on).
- The headlights are darker than normal.
- The horn volume is lower than normal or does not sound.

If the 12-Volt auxiliary battery is discharged, it cannot be jumped started with another battery since the interlock switch will not allow the vehicle to start when the hood is opened. Charge the battery, close the hood, and then try to start the vehicle.