

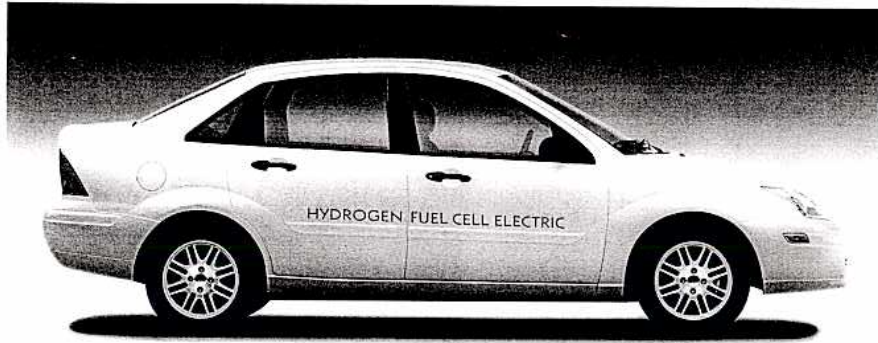
Emergency Responder Guide – Ford Focus FCV

Purpose

These materials provide first responders an understanding of hydrogen and fuel cell technologies and address recommended response procedures in the event of a Fuel Cell Vehicle accident

Topics Covered

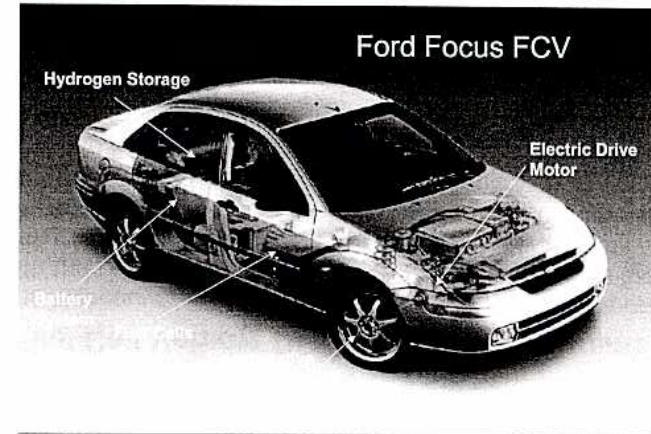
- Ford Fuel Cell Vehicle Demonstration Programs
- Hydrogen
- Hydrogen Fuel Cell Vehicles
- FCV Emergency Response



Hydrogen Fuel Cell Vehicles
Emergency Response

Emergency Responder Guide – Ford Focus FCV

What is a Fuel Cell Vehicle?



Emergency Responder Guide – Ford Focus FCV

Ford Fuel Cell Vehicle Demonstration Programs

- The Vancouver Fuel Cell Vehicle Program is a collaboration with the Government of Canada (Natural Resources Canada, National Research Council, Technology Early Action Measures), the Province of British Columbia, Ford Motor Company and Fuel Cells Canada
- Evaluate Ford Focus fuel cell vehicles under “real world” conditions
- Test, evaluate and refine fuel cell, hydrogen and other new vehicle technologies
- Locations
 - Vancouver, British Columbia
 - Orlando, Florida
 - Sacramento, California
 - Detroit, Michigan
 - Berlin/Aachen, Germany



Emergency Responder Guide – Ford Focus FCV



Ford Focus FCV Features



- Fuel cell and battery electric hybrid
- Electric drive motor
- Regenerative braking
- High voltage (250-400 volts) sources
 - fuel cell
 - Ni-MH batteries
- Low voltage (12 volt) source
 - standard automotive battery
- Hydrogen storage
 - 350 bar (5075 psi)
- Lower pressure hydrogen in fuel lines (outside storage tank)
 - ~3 teaspoons of gasoline equivalent



Emergency Responder Guide – Ford Focus FCV



Add Ballard Video



Emergency Responder Guide – Ford Focus FCV



Hydrogen Compared to Gasoline Vapors

- Gasoline can ignite at lower concentration in air than hydrogen but hydrogen requires lower ignition energy
- Hydrogen is lighter than air and will rise more rapidly away than gasoline vapors
- Hydrogen will disperse more rapidly than gasoline vapors
- Hydrogen has a higher auto-ignition temperature (515 deg. C)



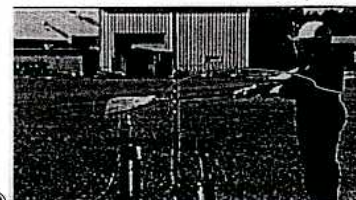
Emergency Responder Guide – Ford Focus FCV



Basic Characteristics of Hydrogen

Hydrogen is:

- Colorless
- Odorless
- Tasteless
- Flammable gas
- 14 times lighter than air
- Burns with a pale blue flame



Emergency Responder Guide – Ford Focus FCV



Time: 3 seconds

The hydrogen fire is shown as the result of venting through the Pressure Relief Device (PRD) with forced ignition



Time: 60 seconds



Time: 90 seconds



*Fuel Leak Simulation (2001) –
Michael Swain, University of Miami*

Emergency Responder Guide – Ford Focus FCV

Testing of Compressed H₂ Storage Tanks

Certification of the hydrogen storage tanks used in the Focus FCV is based on DOT and ANSI/AGA NGV2 certification standards that require for example:

- burst pressure > 2.25 x operating pressure
- cycle test pressure = 1.25 x operating pressure
- pressure cycling
- gunfire permeation tests
- bonfire tests
- burst tests



Emergency Responder Guide – Ford Focus FCV

Hydrogen Safety



Video courtesy of California Fuel Cell Partnership

Emergency Responder Guide – Ford Focus FCV

Compressed H₂ Storage Tank in the Ford Focus FCV

- Type 3 pressure vessel, aluminum-lined tank wrapped with carbon fibers
- Similar to storage tanks in CNG vehicles
- Fully tested and certified for use in automobiles
- Inspected and re-certified every 3 years
- Factory installed in vehicle
- Approximately 350 bar (5075 psi)



Emergency Responder Guide – Ford Focus FCV

HYDROGEN STORAGE & LINES

VEHICLE IS EQUIPPED WITH AN INERTIA SWITCH TO AUTOMATICALLY DISCONNECT HIGH VOLTAGE AND SHUT OFF HYDROGEN FLOW IN CASE OF AN ACCIDENT. HOWEVER, ALWAYS ASSUME THE VEHICLE IS POWERED.



Compressed Hydrogen warning decal – as indicated on the left is located on the deck lid, to uniquely identify the vehicle and indicate onboard storage of compressed hydrogen.

- The in-tank shut off valve isolates the hydrogen system when the ignition key is in the off position. However, the hydrogen lines remain pressurized with a limited amount of hydrogen.
- The PRD (Pressure Relief Device) is intended to release hydrogen from the tank in case of excessive heat or fire.
- Never cut Hydrogen Tank, hydrogen lines and components attached to the tank or the PRD vent line.



Emergency Responder Guide – Ford Focus FCV

**Think Safety:
Do Not Rush In!**

- Position responding apparatus uphill, upwind, and away from the H₂ vent direction of accident
- Follow the standard vehicle approach method (45 degree approach angle) taking into account the location and direction of the H₂ PRD vent



Emergency Responder Guide – Ford Focus FCV

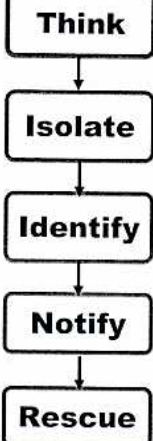
Vehicle Safety Systems

- **Hydrogen Sensors**
 - Detect hydrogen leakage (only when vehicle systems are active)
- **Impact sensors**
 - Detect vehicle impact (Shuts down H₂ fuel system and high voltage system)
- **Pressure Relief Device (PRD)**
 - Activates if there is excessive temperature/pressure (Resulting in H₂ release through vent line and PRD)



Emergency Responder Guide – Ford Focus FCV

**FCV
EMERGENCY
PROCEDURE**



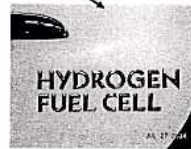
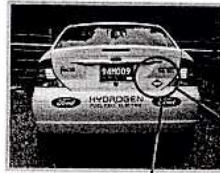
Developed by Richmond CA Fire in conjunction with California Fuel Cell Partnership



Emergency Responder Guide – Ford Focus FCV

Identify

- Vehicle graphics indicating Fuel Cell and Hydrogen
- Blue Diamond "Compressed Hydrogen" on trunk lid
- "Hydrogen Fuel Cell" on trunk lid
- Identify hazard & effects on:
 - Public safety / first responders
 - Refer to MSDS



Emergency Responder Guide – Ford Focus FCV

Identify Critical Areas

- Identify the location of the H2 PRD vent (trunk lid) before beginning any operation around the vehicle (see ER sheets)
- Keep clear of H2 PRD vent location
- See shutdown procedure and reference diagrams on next three slides



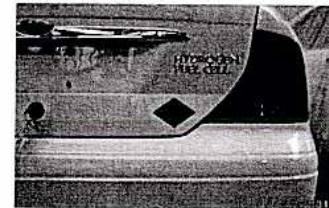
Emergency Responder Guide – Ford Focus FCV

Isolate the Area

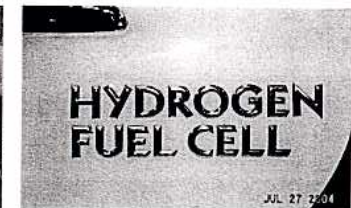
- Isolate the area and **assure the safety** of people and environment according to ER Guide 115
- Initial perimeter recommended 150 meters
 - Source: NASA/West Sacramento, CA Fire Department
- Assess, then close in perimeter at direction of first command on scene
- Keep people **away** from the scene



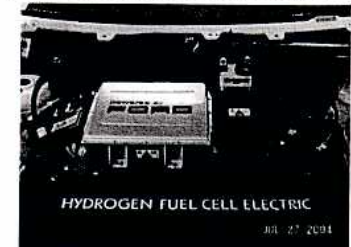
Emergency Responder Guide – Ford Focus FCV



Hydrogen Fuel Cell rear badge and Compressed Hydrogen decal on the deck lid



Add FCC Vehicle Graphics

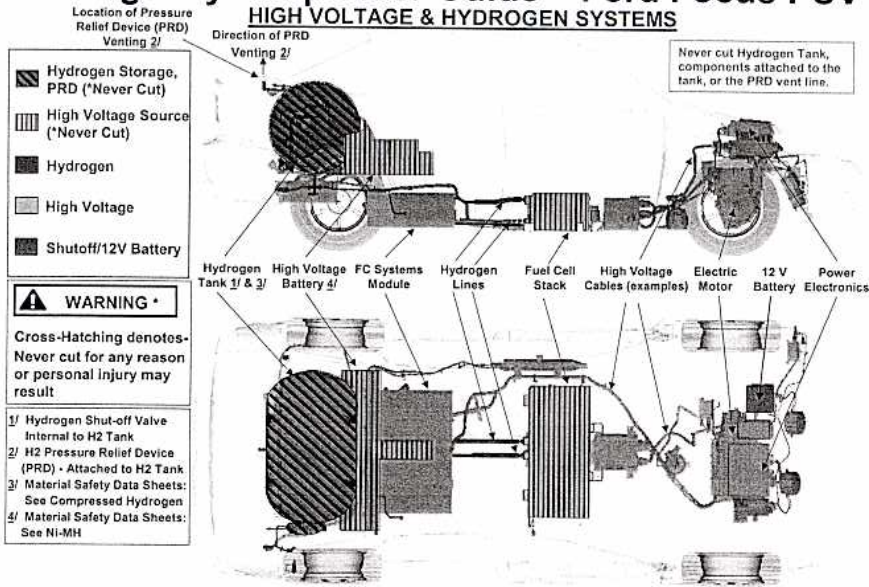


Hydrogen Fuel Cell Electric body side graphics & unique underhood graphics



Emergency Responder Guide – Ford Focus FCV

HIGH VOLTAGE & HYDROGEN SYSTEMS

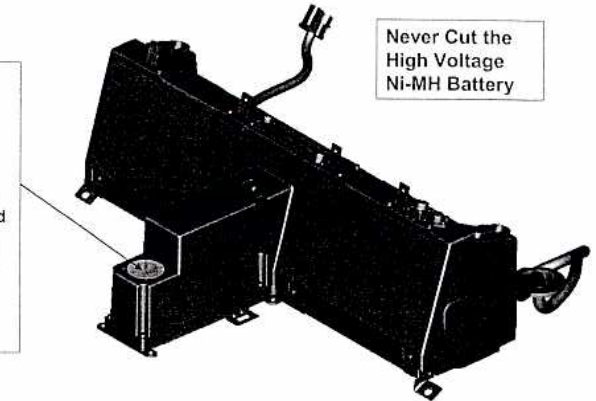


Emergency Responder Guide – Ford Focus FCV

HIGH VOLTAGE BATTERY ISOLATION

NOTE:
This procedure renders the rear seat unusable.

To remove the High Voltage Service Disconnect Switch, turn it counter clockwise and lift it out. The switch is located under the rear seat arm rest. Lift the rear edge (back edge) of the lower seat cushion to gain access to the High Voltage Service Disconnect Switch



Emergency Responder Guide – Ford Focus FCV



NOTE: The following actions will result in the shut-down of the hydrogen and electrical system

- Place vehicle in park
AND
- One of the following:
 - Turn ignition key "off" and remove key
 - Disconnect negative (-) battery terminal

B



A

Emergency Responder Guide – Ford Focus FCV

HIGH VOLTAGE & HYDROGEN SYSTEMS

VEHICLE IS EQUIPPED WITH AN INERTIA SWITCH TO AUTOMATICALLY DISCONNECT HIGH VOLTAGE AND SHUT OFF HYDROGEN FLOW IN CASE OF AN ACCIDENT. HOWEVER, ALWAYS ASSUME THE VEHICLE IS POWERED.

Key

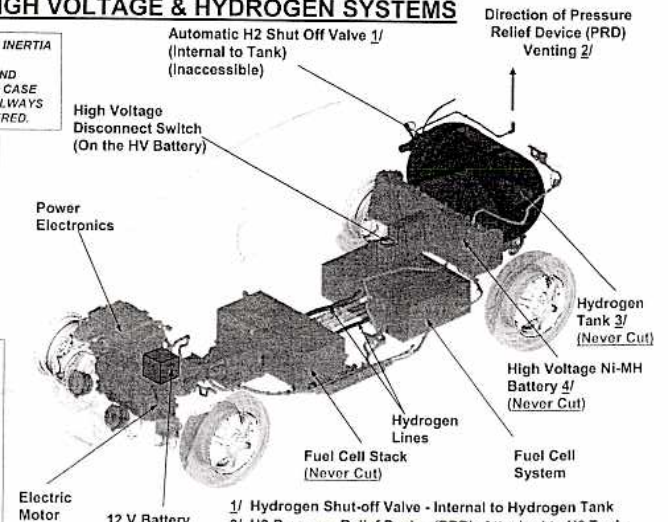
- Hydrogen
- High Voltage (Avoid cutting unless equipped with High Voltage protection)
- 12V Battery

Never cut Hydrogen Tank, components attached to the tank, or the PRD vent line.

HV BATTERY DISCONNECT SWITCH REMOVAL

NOTE: This procedure renders the rear seat unusable.

To remove the High Voltage Service Disconnect Switch, turn it counter clockwise and lift it out. The switch is located under the rear seat arm rest. Lift the rear edge (back edge) of the lower seat cushion to gain access to the High Voltage Service Disconnect Switch.



- 1/ Hydrogen Shut-off Valve - Internal to Hydrogen Tank
- 2/ H2 Pressure Relief Device (PRD) - Attached to H2 Tank
- 3/ Material Safety Data Sheets: See Compressed Hydrogen
- 4/ Material Safety Data Sheets: See Ni-MH

Emergency Responder Guide – Ford Focus FCV

Notify

Notify responsible agencies

- Local FCV Fleet Program Manager
- Ford Motor Company Site Manger

Contact information is located on the driver's side visor and on the ER sheets in the responding apparatus/engine



Emergency Responder Guide – Ford Focus FCV HIGH VOLTAGE SYSTEM

VEHICLE IS EQUIPPED WITH AN INERTIA SWITCH TO AUTOMATICALLY DISCONNECT HIGH VOLTAGE AND SHUT OFF HYDROGEN FLOW IN CASE OF AN ACCIDENT. HOWEVER, ALWAYS ASSUME THE VEHICLE IS POWERED.



- High Voltage warning decals – as indicated on the left will be located on the components included in the high voltage system.
- All High Voltage wiring have an orange covering.

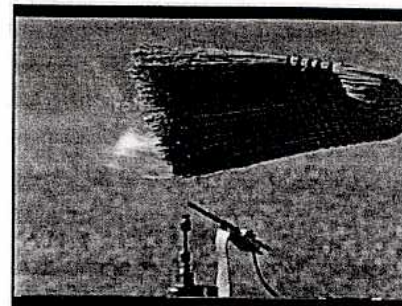
- Avoid cutting High Voltage lines unless equipped with high voltage protection gear.
- The High Voltage (HV) system is disconnected when the vehicle ignition key is turned to the off position.
- There is an interlock circuit on all HV connectors that disables the high voltage system when a high voltage connector is removed/opened.
- **Caution:** Residual current may be present on orange HV lines after disconnection.
- The HV battery system is disconnected when the HV Service Disconnect Switch is removed. To remove this switch, turn it counter clockwise and lift it out. The switch is located under the rear seat arm rest. Lift the rear edge (back edge) of the lower seat cushion to gain access to the HV Service Disconnect Switch.
- The HV battery system contains an internal fuse that will open in the event of a high current short circuit.
- Exposure to battery electrolyte could cause skin/eye irritation and or burns. If exposed, rinse with large amounts of water.



Emergency Responder Guide – Ford Focus FCV

Detect H₂ Release

- H2 Fire Detection
 - UV/IR Detectors
 - Long Handle Broom
- H2 Leak Detection
 - Thermal Conductivity Sensor
 - Catalytic Combustion Sensor
 - Electrochemical Sensor
 - Loud hissing sound
 - Frost around H2 vent location



Emergency Responder Guide – Ford Focus FCV

Rescue

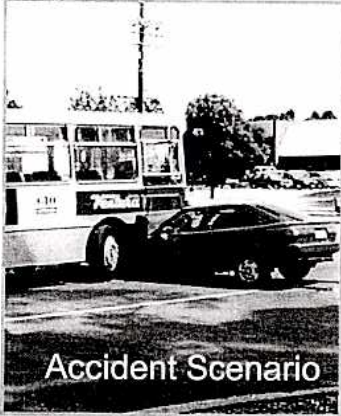
Before attempting to rescue occupants or to move a damaged vehicle, make sure you:

- Wear recommended safety equipment
 - PPE-Turn-outs & SCBA
- Detect H2 release and / or fire
 - UV / Thermal Imaging / Straw Broom
- Identify Low and High Voltage Systems
 - 12 Volt - battery located under hood (normal location)
 - 200-400 Volt – Bright Orange
- Follow "Emergency / Manual Shut Down" procedure
 - Located in responding apparatus/engine



Emergency Responder Guide – Ford Focus FCV

Accidents Involving a FCV and Liquid-Fueled Vehicle



- Move the liquid-fueled vehicle away from the FCV when it is safe to do so
- If there is a gasoline or diesel fuel spill near a FCV, spray the spilled fuel with foam to render the fuel inert if safe to do so



THANK YOU!

For additional information on fuel cells and related technologies visit the following websites:

www.vfcvp.go.ca

www.ford.com

www.ballard.com

www.fuelcellscanada.ca

www.caafcp.org

www.energy.gov

Emergency Responder Guide – Ford Focus FCV

Fire on-board... What to do?

- Shut down vehicle as soon as it is safe; this action closes solenoid valves isolating the fuel storage system
- If fire continues, use standard fire fighting techniques
- Isolate source of H₂ by following shutdown procedure
- **If hydrogen source cannot be isolated**
 - **DO NOT EXTINGUISH H₂ FLAME**
LET IT BURN!
(Because a H₂ fire will dissipate within a few minutes)
- Prevent fire from spreading
- Protect exposures



Emergency Responder Guide – Ford Focus FCV

Rescue Summary

- Position and approach upwind and uphill
- Approach a FCV **away** from the PRD vent
- Do **not** stand near or in the stream of a PRD vent
- Follow Emergency Shut Down procedures
- Do **not** cut High Volt System
- Avoid Fuel Cell System components
- Turn off source the of H₂ – **if you can not...**
- Do **not** extinguish H₂ flame – **LET IT BURN**
- If fire continues, use standard fire fighting techniques

