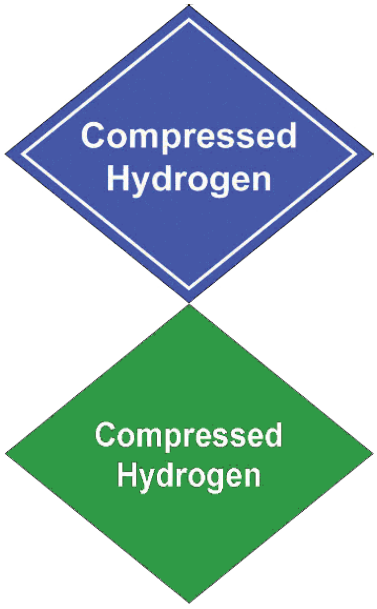
FIRST RESPONDER SAFETY: HYDROGEN AND HYDROGEN-POWERED VEHICLES

HYDROGEN

Hydrogen is colorless, odorless, tasteless, non-toxic, and non-corrosive. This excellent source of energy is the most abundant element on Earth. Hydrogen easily combines with almost every other element (e.g., oxygen). Most hydrogen is locked up in enormous quantities in water, hydrocarbons, and other organic matter. Efficiently producing hydrogen from these compounds is one of the challenges of using hydrogen as a fuel. Currently, steam reforming of methane (natural gas) accounts for about 95% of the hydrogen produced in the United States.



Hydrogen Labels. *Source: NAFTC*

Like natural gas, hydrogen can be stored in two forms:

Gaseous. Gaseous hydrogen is compressed to store sufficient quantities.

Liquid. Liquid hydrogen is typically used as a concentrated form of hydrogen storage. To exist as a liquid, H2 must be pressurized and cooled to a very low temperature, –423.17 °F/–252.87°C. As with any gas, storing it as liquid takes less space than storing it as a gas at normal temperature and pressure.

HYDROGEN-POWERED VEHICLES

Hydrogen vehicles are still largely in development with a limited number of vehicles in use by select organizations and consumers in certain areas. Hydrogen can be used to power vehicles in two ways: (1) in an internal combustion engine (ICE) hydrogen-powered vehicle by igniting the hydrogen to release its energy or (2) in a fuel cell electric vehicle (FCEV) electrochemically, by passing molecules through a fuel cell.

ICE Hydrogen-Powered Vehicles. In an ICE hydrogen-powered vehicle, hydrogen is stored in fuel tanks and burned by the ICE, converting the hydrogen into mechanical energy. The functions of the transmission and drive train are identical to those of a conventional vehicle, though using hydrogen to power an ICE requires modification to the engine calibration and fuel management systems.

Fuel Cell Electric Vehicles. FCEVs use electricity to power motors located near the vehicle's wheels. In contrast to electric vehicles, fuel cell vehicles produce their primary electricity using a fuel cell. The fuel cell is powered by filling the fuel tank with hydrogen. FCEVs may differ from one to another, but usually have several basic components in common: an electric motor, a battery pack, a hydrogen fuel tank, and a fuel cell stack. Electricity is generated by fuel cells to power an electric motor and accessories. The main byproducts of the fuel cell reaction are water and heat.

Hydrogen fuel cell bus. *Source: National Renewable Energy Laboratory (NREL) Photographic Information eXchange (PIX)#16143*

VEHICLE SAFETY

Hydrogen vehicles undergo the same rigorous testing as conventional vehicles and will be required to meet all the same standards for safety, including crash and airbag testing. First responders must understand the different components that make these vehicles unique in an emergency situation. Hydrogen has the widest range of flammability compared to other fuels. Under optimal combustion conditions, the energy required to initiate a hydrogen combustion is much lower than other common fuels. The automotive industry has taken this into consideration when the vehicles are built to include many safety systems. These include sampling of the air for hydrogen concentrations, monitoring pressure levels and stratgic use of pressure release devices to name a few. The high voltage battery pack is no more of a concern on a FCEV than that of a HEV.

U.S. STATISTICS

- Though they are not commercially available on a national scale, there were approximately 313 hydrogen vehicles in use in the United States as of 2008.[1]
- In 2008, approximately 117,000 gasoline gallon equivalents (GGEs) of hydrogen were used in vehicles.[1]
- As of May 2010, there were approximately 56 hydrogen fueling stations in the United States.[2]

[1] U.S. Energy Information Administration, Alternatives to Traditional Transportation Fuels 2008.
[2] U.S. Department of Energy, Alternative Fuels & Advanced Vehicles Data Center (AFDC).

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FIRST RESPONDER INFORMATION

Important considerations when responding to an incident involving a hydrogen-powered vehicle:

- Approach the vehicle with caution and only with the appropriate training.
- Eliminate all ignition sources.
- Stay upwind and away from vapors and leaks.
- Look, smell, feel and/or use sensors to detect leaking fuel or a fire.
  - o If the vehicle is on fire or a leak is detected, do not approach the vehicle.
  - o If no fire or leak is detected, isolate the fuel system.

In the case of a vehicle fire:

- Isolate the fire, if possible.
- Extinguish the fire.
- Be aware that, if the flame is extinguished without stopping fuel flow, the fire may reignite.

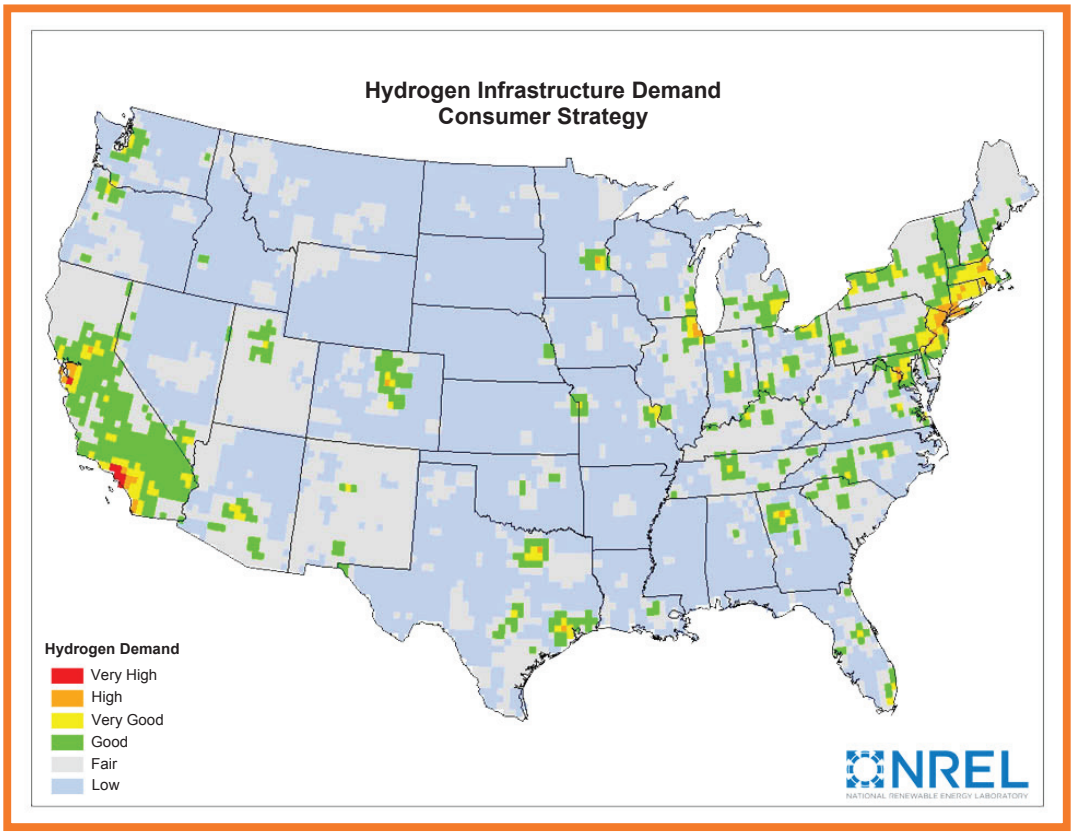
In the case of hydrogen spill or leak, isolate the area until the gas has dispersed and use water spray to reduce vapors or divert vapor cloud drift.

If extrication is necessary:

- Be sure there are no vapors or fuel leaks that could ignite.
- Know cribbing points and cut zones before cutting into a vehicle.
- Avoid cutting critical components.

ADDITIONAL RESOURCES

- U.S. Department of Energy, Alternative Fuels & Advanced Vehicles Data Center: http://www.afdc.energy.gov/afdc/
- National Hydrogen Association: http://www.hydrogenassociation.org/
- National Fire Protection Association: http://www.nfpa.org/



Hydrogen demand map. *Source: NREL In this map, the National Renewable Energy Laboratory (NREL) analyzed demographic, socio-economic, transportation, and policy data that influence hydrogen demand. The demand scenarios were further used to estimate infrastructure needs and usage throughout the country and to predict transition infrastructure costs.*

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