Virginia Clean Cities

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Autogas for First Responders

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March 4, 2014

Propane Autogas

A Safe, Economic, and Environmentally Friendly Option for Fleet Vehicles

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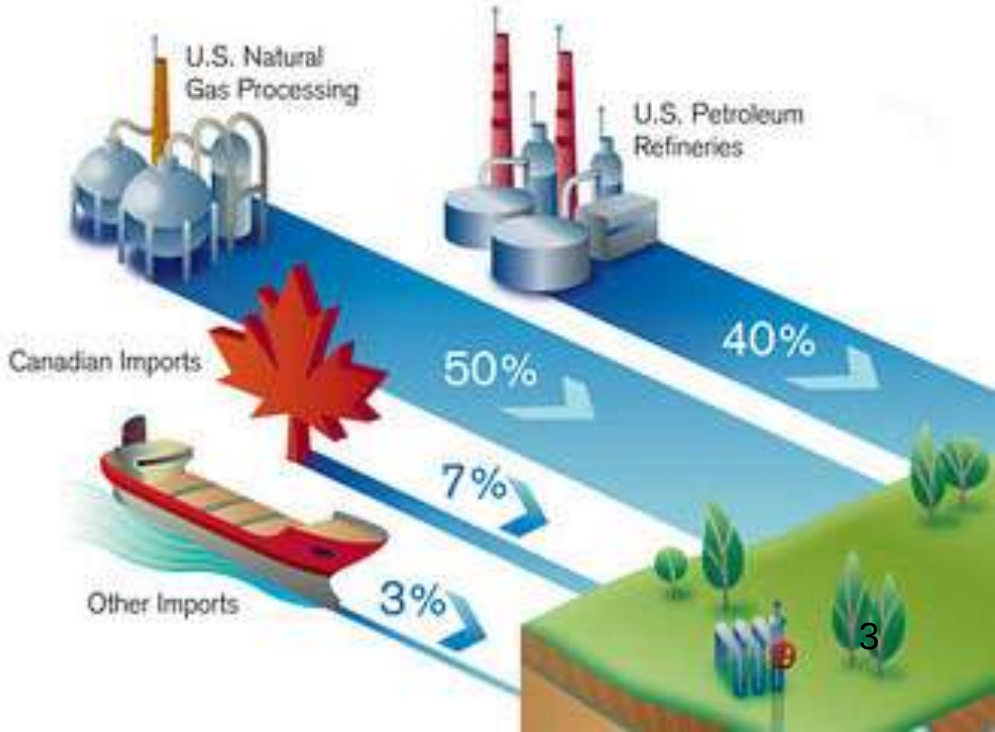
PROPANE education & research COUNCIL

PROPANE EXCEPTIONAL ENERGY

Domestically Produced

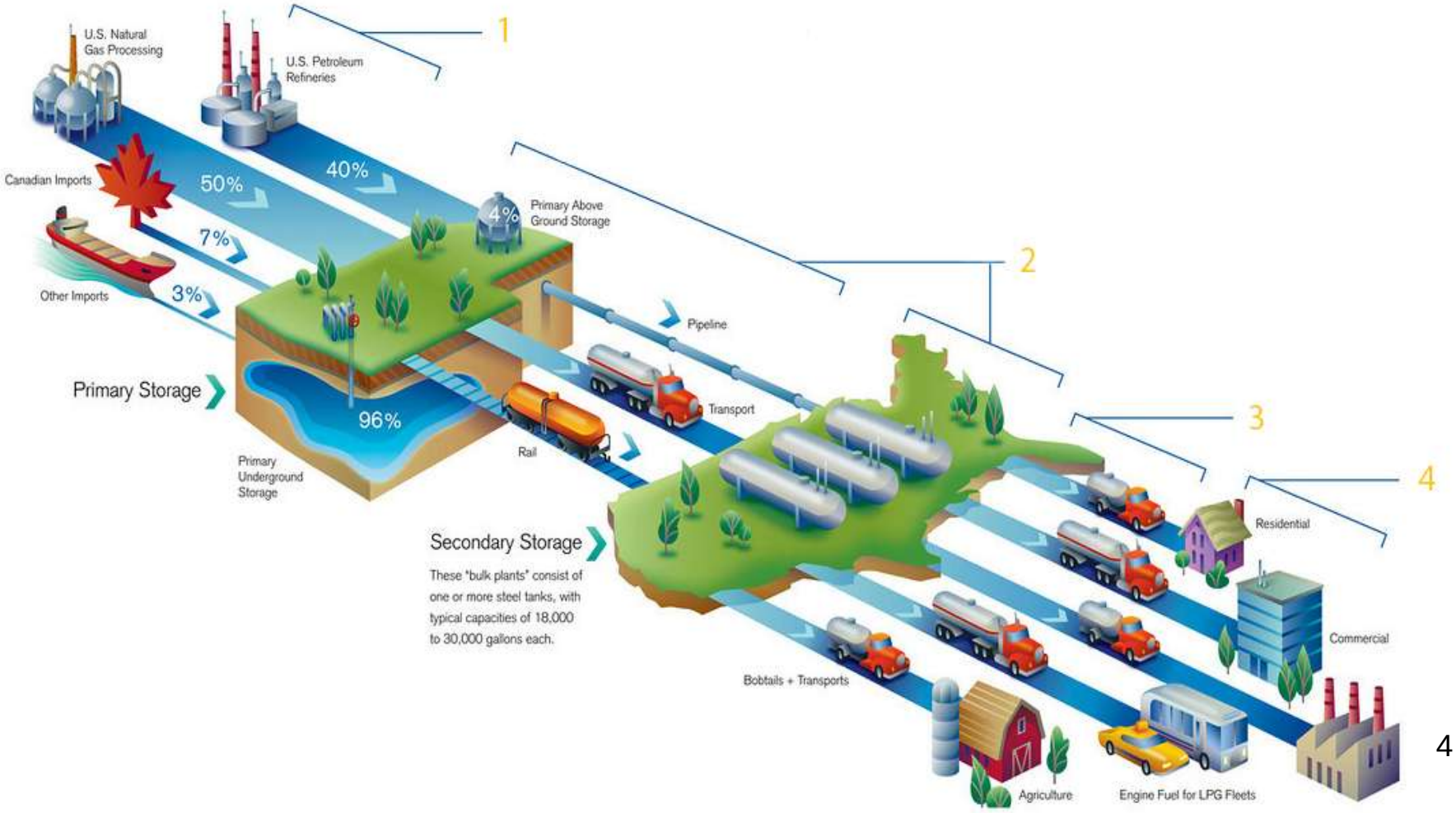
- Approximately 90 percent of propane consumed in the U.S. is produced domestically

- An additional 7 percent is produced in Canada

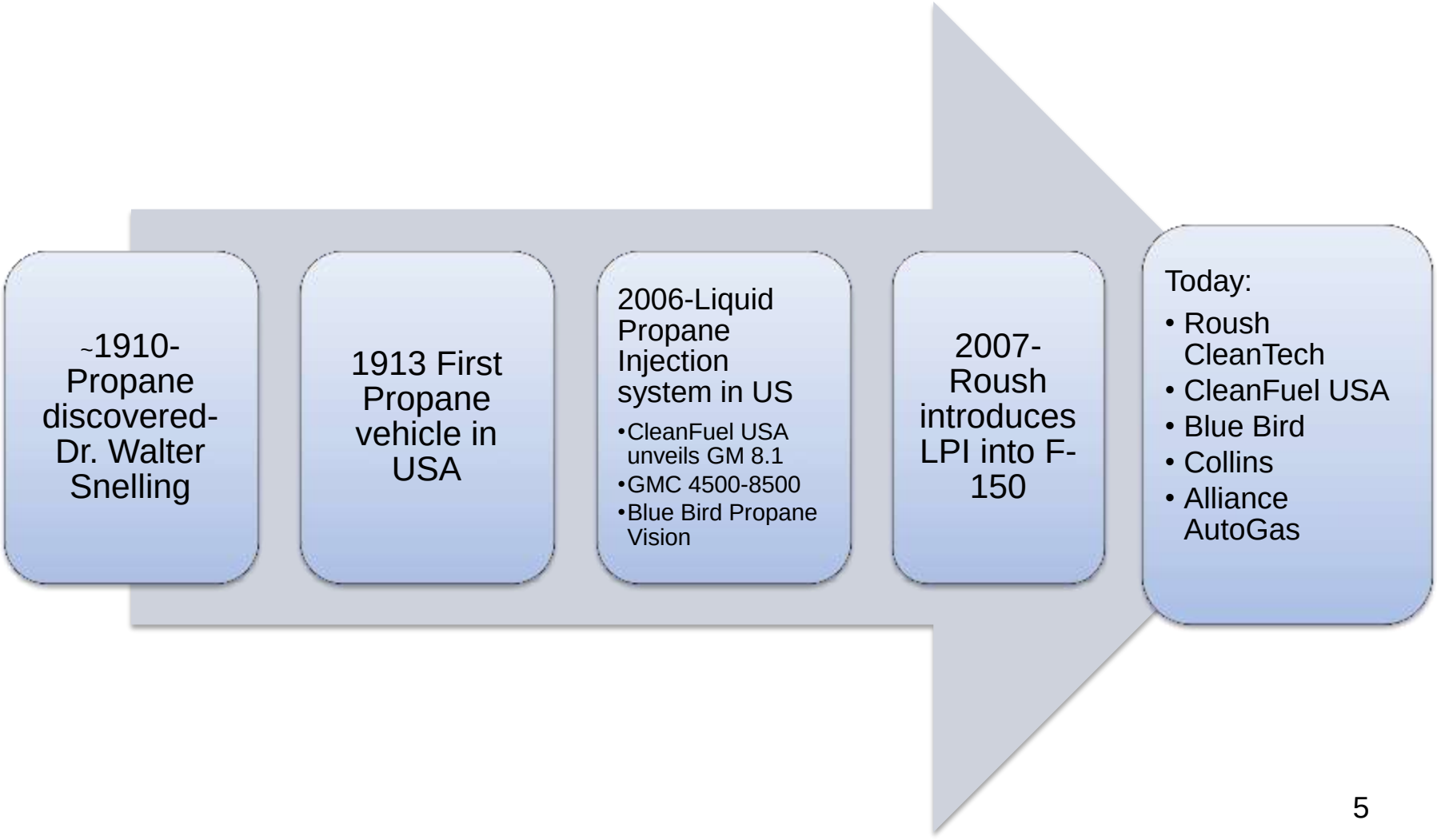


Domestically Produced

Propane Distribution Network



History of propane autogas

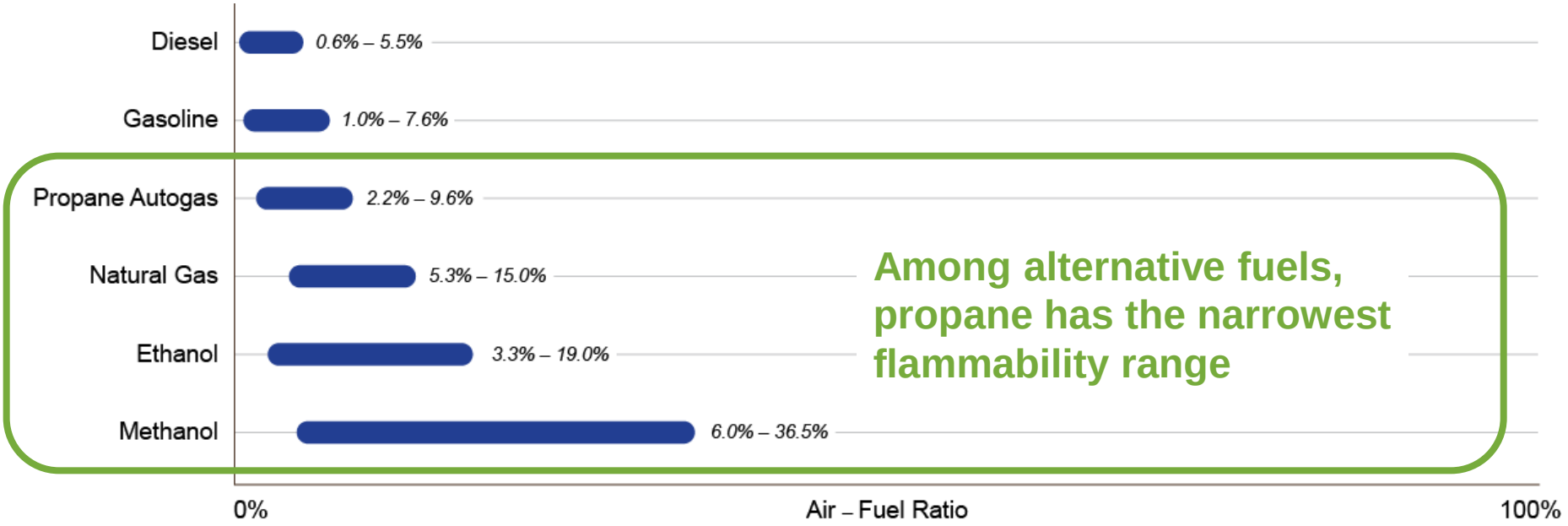


Propane Autogas as an Alternative Motor Fuel

- ~270,000 propane vehicles in US
- ~15M propane vehicles worldwide
- Referred to as “Autogas”
- Move in US to use propane autogas for propane used in on-road applications.

Safety Advantages of Propane Autogas

Flammability Range



Safety Advantages of Propane Autogas

- Built-in safety devices and shut-off valves
- Propane tanks are 20 times more puncture-resistant than gasoline tanks

Propane-Autogas-Fueled Vehicles Meet Strict Set of Rules and Requirements

- The Department of Transportation
- National Highway Traffic Safety Administration
- Environmental Protection Agency

Propane-Autogas-Fueled Vehicles Meet Strict Set of Rules and Requirements

- American Society of Mechanical Engineers
- National Fire Protection Association
- Underwriters' Laboratory

Propane Properties

- Tasteless, colorless, and naturally odorless
- Propane manufacturers add odorant (ethyl mercaptan)
- Capable of being either liquid or gas; in ambient conditions, it is a gas
- Flammability range of 2.2 percent to 9.6 percent
- Approximate ignition temperature of 920 degrees Fahrenheit
- If liquid propane leaks, it will vaporize and dissipate into the air (will not puddle)

Propane Properties

- Stored and transported as a liquid (under pressure) and can vaporize under the proper conditions
- Vaporizes at approximately -44 degrees Fahrenheit
- One cubic foot of propane will boil off (expand) into 270 feet of vapor
- If liquid propane contacts skin, immediate frostbite results

Vehicle Identification

- Propane identification decals are mounted on the lower right rear of the vehicle (above the bumper)
- Decal is black, diamond shaped with a luminous light silver or white border, and with the word “PROPANE”

Vehicle Components

- Fuel tank
- Fuel tank mounting and bracket system
- Fuel system and line

Fuel Tanks

- Built in several shapes and sizes
- Installed in a variety of locations (depending on the type of vehicle)
- Vehicles may have more than one tank
- Tanks rated for 312 psig
- Pressure-relief valves vent to outside of vehicle
- 20 times more puncture-resistant than a gas tank
- Equipped with manual shutoff, excess flow, and automatic closure features

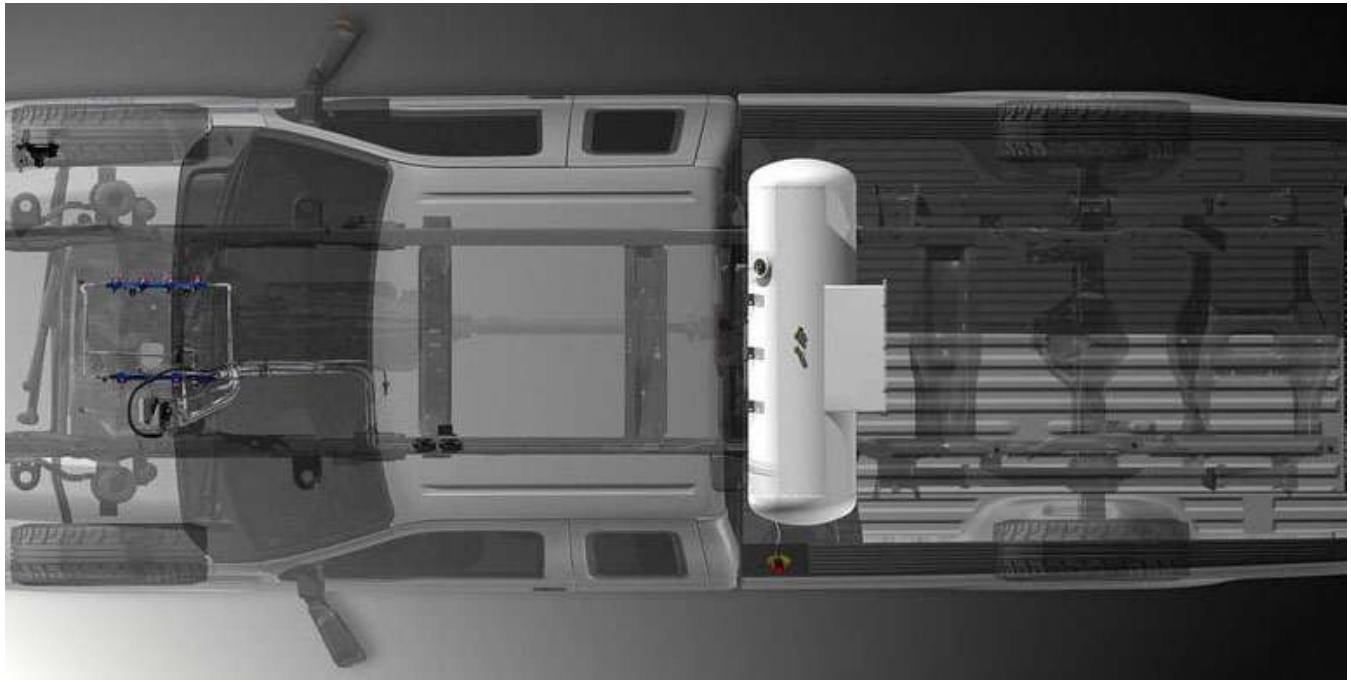
Fuel Tanks

- The location of manual shutoff valves are typically marked on many vehicles

Fuel Tank Mounting & Bracket Systems

- Fuel tanks can be mounted inside or outside of a vehicle
  - Typical exterior mounts include:
    - Pickup truck bed
    - Under a flat or stake bed of a truck
    - Along the frame rails of a truck or bus
  - Typical interior mounts include:
    - Trunk of a passenger car (e.g., taxi and police car)
    - Rear of a van, minivan, or SUV
    - Must be installed with protective enclosure to prevent leaks to passenger compartment
- All tanks must be protected to prevent damage from objects encountered on roadways

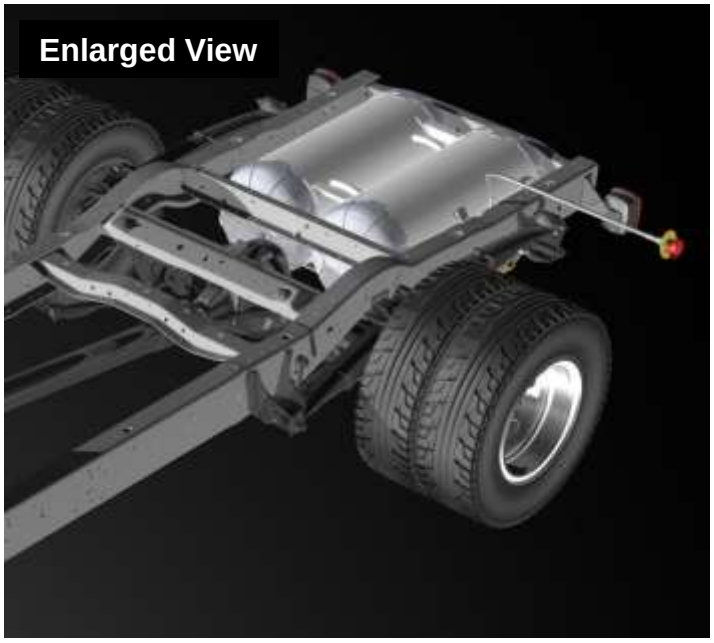
Fuel Tank Mounting & Bracket Systems



Images courtesy of Roush CleanTech

- Exterior mount on pickup truck bed

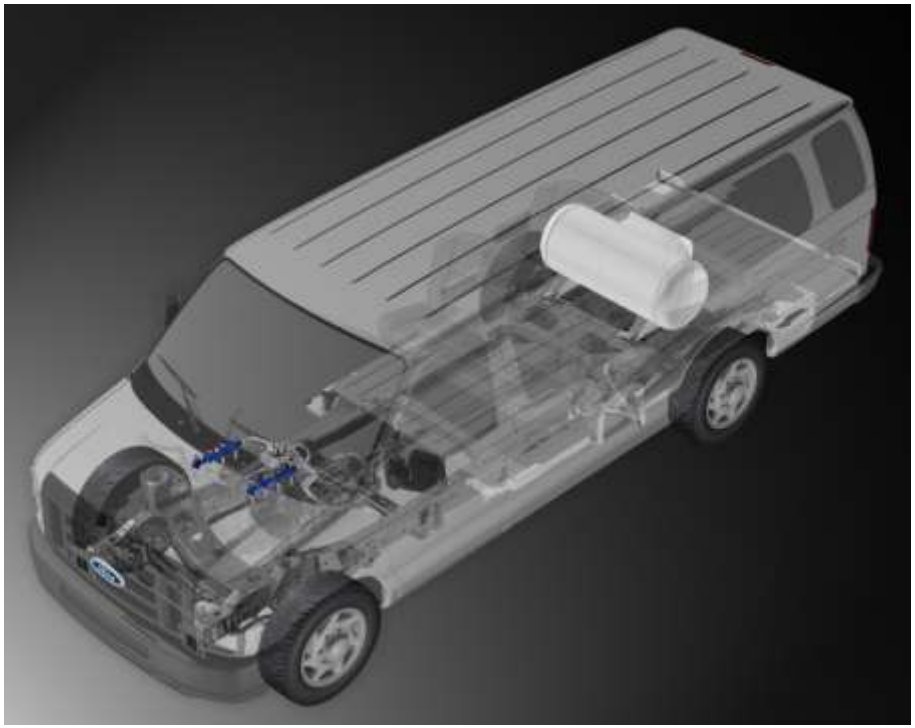
Fuel Tank Mounting & Bracket Systems



Images courtesy of Roush CleanTech

- Exterior mount on DRW cabin chassis

Fuel Tank Mounting & Bracket Systems



Images courtesy of Roush CleanTech

- Interior mount in van

Fuel Tank Mounting & Bracket Systems

- Larger vehicles and buses may have bracket systems
  - Buses utilize a bracket system that provides added protection
  - Tanks located between bus frame rails

Fuel Systems and Lines

- Two types of fuel systems
  1. Vapor fuel injection system
     - Stored in tank in liquid form at low pressure
     - Passes through fuel line to engine, converted to vapor by a regulator
     - Vapor mixes with air and enters combustion chamber
     - Similar to a traditional vehicle carburetor system

Fuel Systems and Lines

2. Liquid fuel injection system
   - New and popular technology
   - Liquid propane is directly injected into the combustion chamber
   - Improves engine durability and power output

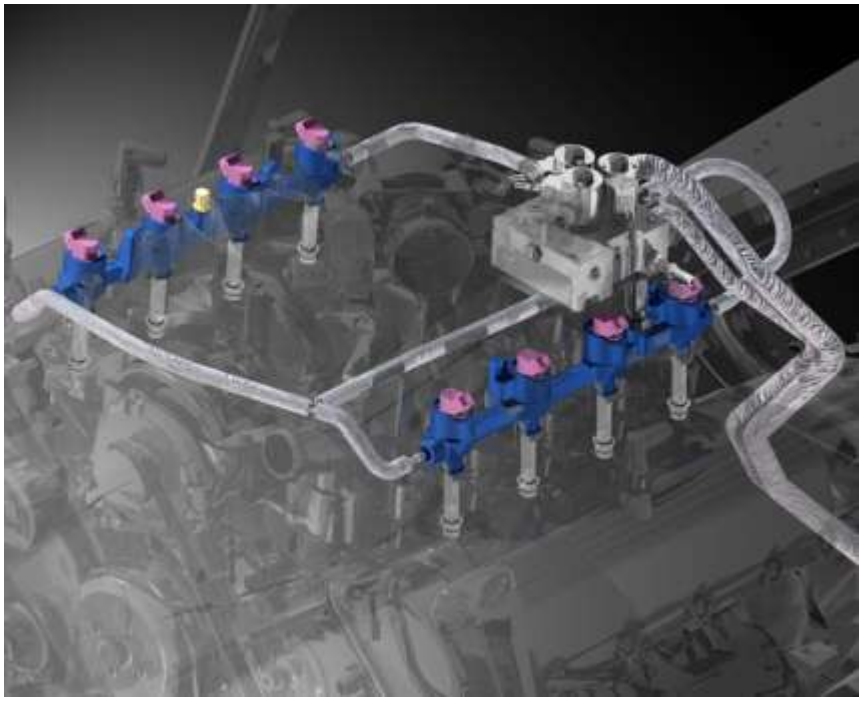


Image courtesy of Roush CleanTech

Fuel Systems and Lines

- Propane autogas fuel lines are typically routed through the vehicle in the same location as the original factory fuel lines
- Fuel lines are typically made of stainless steel to handle the varying temperatures and pressures of liquid propane
- An automatic shutoff valve prevents the flow of fuel to the engine when it is not running, even if the ignition switch is in the “on” position

Vehicle Refueling

- Distinct differences in propane autogas dispensing systems
  - Sealed systems
  - Operate under higher pressure
- Above-ground storage
- Tanks filled to 80% to allow expansion


PROPANE
EXCEPTIONAL ENERGY®

First Responder Safety Training

Liquefied Petroleum Gas and Liquefied Petroleum Gas Vehicles

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www.cleancities.energy.gov/

Acknowledgment: This material is based upon work supported by the U.S. Department of Energy Clean Cities Program under Award Number DE-EE0001696.

National Alternative Fuels Training Consortium

Mission Statement

"To improve air quality and decrease U.S. dependence on foreign oil by promoting, supporting, and expanding the use of advanced technology vehicles and alternative fuel vehicles."

- Program of West Virginia University, headquartered in Morgantown, WV
- Founded in 1992
- Only nationwide curricula development and training organization that focuses on alternative fuel and advanced technology vehicles

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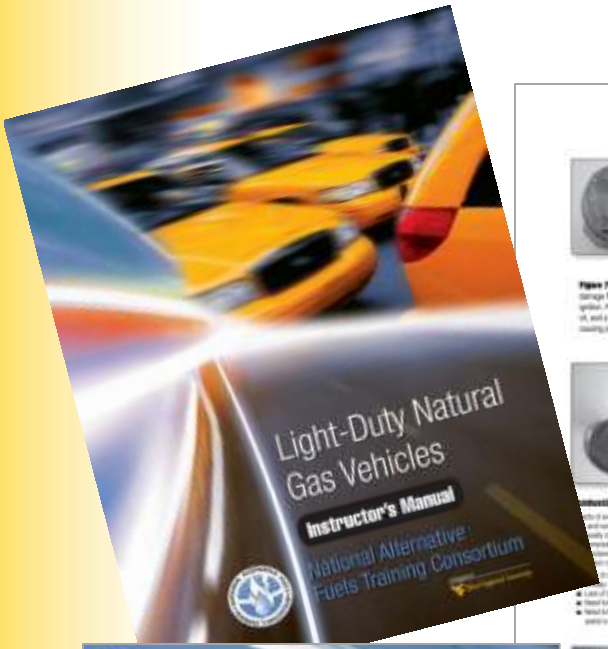
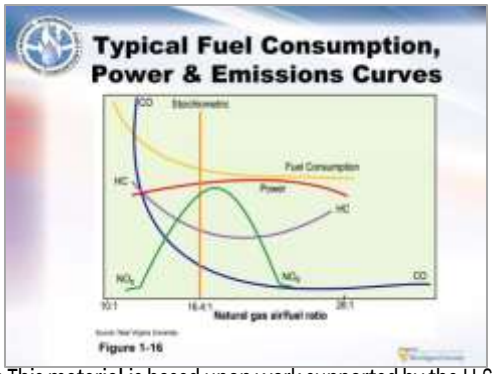
State-of-the-Art Curriculum Development





- Over 25 courses and workshops
  - Available on all types of alternative fuel and advanced technology vehicles
  - Customizable to meet needs and requirements of the audience
    - Electric Drive Vehicle Technician
    - Natural Gas Vehicle Technician
    - Propane Vehicle Technician
    - Ethanol Vehicle Technician
    - Biodiesel Vehicle Technician
    - Hydrogen Vehicle Technician
    - First Responder
    - Awareness Presentations
    - Electric Vehicle Infrastructure

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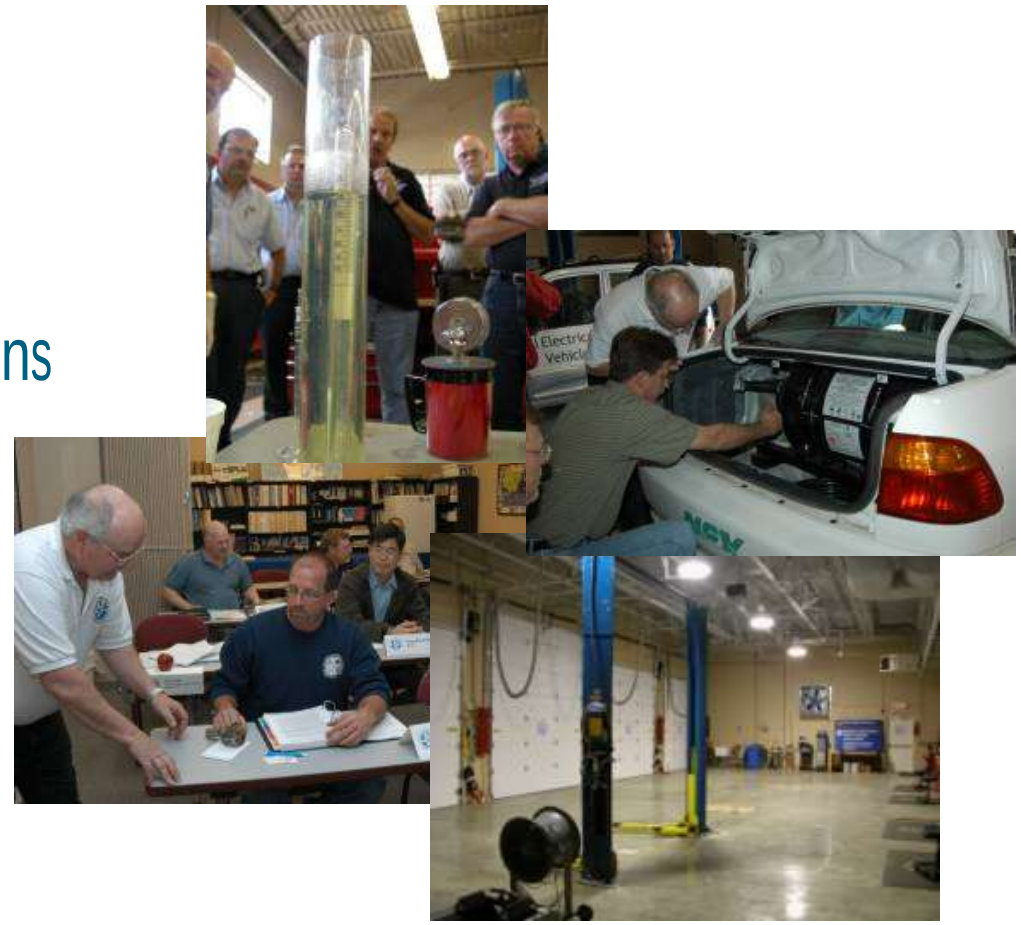
Training Classes and Venues

- Classroom study
- Lab activities
- Hands-on shop applications
- Classes held at our facility in Morgantown, WV or at your location



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About this Presentation

LPG and LPG Fueled Vehicles

With the nation's growing interest in producing vehicles with high fuel efficiency and fewer emissions, first responders must be ready to respond to incidents involving the new generation of alternative fuel and advanced technology vehicles.

This workshop covers propane, propane properties, propane as a fuel, and will properly train and educate first responders on the chemical properties, manufacturing and production, vehicles, infrastructure, transport, stations, and handling, as well as first responder procedures related to LPG vehicles.

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Part 1:
First Responder Procedures

Part 1 Overview

Part 1, *First Responder Procedures*, reviews how first responders should approach and assess an LPG incident, required personal protective equipment (PPE) for responding to an incident, general firefighting measures, and extrication.

Acknowledgment: This material is based upon work supported by the U.S. Department of Energy Clean Cities Program under Award Number DE-EE0001696.

Part 1 Objectives

After completing Part 1, you will be able to:

- List personal protective equipment (PPE) required when responding to a gaseous fuel-related incident
- List the emergency procedures involving gaseous fuel storage, transport, distribution, and handling
- List the steps required to secure a gaseous fuel vehicle during an accident
- List the steps required when rescuing occupants from a damaged gaseous fuel vehicle
- Demonstrate proper fire response to gaseous fuel fires regarding fueling stations, vehicles, and tanks
- Demonstrate proper response to a gaseous fuel leak

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Approaching, Assessing, and Securing

When approaching an LPG incident:

- DO NOT rush in
- Position fire trucks, police cruisers, and ambulances uphill/upwind and away from possible vapors, spills, and/or leaks
- Regarding tanker trucks or large spills, contact hazmat immediately
- Keep unauthorized personnel away
- Isolate the area for at least a half mile (800 meters) in all directions

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Approaching, Assessing, and Securing

- Stay uphill/upwind of vapors
- Look for leaking fuel and watch for thermal waves that could signal propane flames

Special Note:

If possible, eliminate all potential ignition sources and DO NOT touch or walk through an area that has vapors.

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Approaching, Assessing, and Securing

Propane Flames:

- Burn pale blue — nearly invisible in daylight
- Have very high radiant heat
- May appear yellow if impurities like dust or sodium from the ocean spray, exist in the air: this is often the case with large propane explosions.

Natural gas flame.
Source: NAFTC

Propane flame.
Source: NAFTC

Special Note:

It is critical that first responders use a UV optical sensor, flame sensor, or thermal imaging camera (TIC) when approaching the scene of a natural gas or propane incident.

Acknowledgment: This material is based upon work supported by the U.S. Department of Energy Clean Cities Program under Award Number DE-EE0001696.

Approaching, Assessing, and Securing

- To detect a gaseous fuels leak, use:
  - Thermal conductivity sensors
  - Catalytic combustion sensors
  - Electrochemical sensors
- Listen and watch for alarms
- When it is safe to do so, listen for the sound of fuel escaping around the PRD vent of vehicles

Equipment recommended for detecting gaseous fuel leaks.
Source: Ford Advanced Technologies

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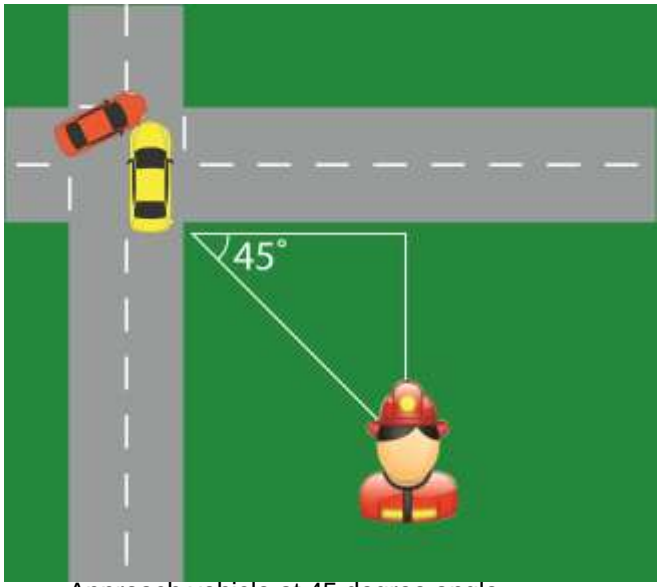
Securing Gaseous Fuel Vehicles

- When approaching a LPG vehicle:
  - Approach at a 45° angle when possible
  - Helps avoid direct exposure in the case of a pressure relief valve (PRV) release
- Propane that escapes from PRV is under high pressure and may ignite



Approach vehicle at 45 degree angle
Source: NAFTC

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Securing Gaseous Fuel Vehicles

When securing an gaseous fuel vehicle that has been involved in an incident:

- Follow standard operating procedures
- Immobilize, stabilize, and disable
- If on fire or a leak is detected, DO NOT approach the vehicle
- Secure the scene with nonsparking markers or cones

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Securing Gaseous Fuel Vehicles

If the vehicle is not on fire and no obvious leak is detected:

- Isolate fuel system
- If possible, close manual shut-off valve and cylinder valves
- Be aware of safety features such as airbags and seat belt pretensioners
- Chock wheels and set parking brake

Turning off ignition key.
Source: DOE

Cutting negative cable(s) of a 12-volt battery.
Source: DOE

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Identifying Gaseous Fuel Vehicles

- First responders must identify whether the vehicle is:
  - Conventional Vehicle
  - CNG
  - LNG
  - LPG
- Look for special fuel ports, distinctive profiles, and any written markings
- The industry, vehicle manufacturers, and conversions normally place a decal or emblem on the vehicle

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Identifying Gaseous Fuel Vehicles

Look for a diamond shaped decal with the lettering "propane"

- On the side, trunk, tailgate, or tank areas
- Identifies vehicle as capable of using propane
- May not be visible if vehicle has been in a collision

Propane vehicle identification.
Source: NAFTC

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Quick Reference Guide

Quick Reference Guide

The NAFTC has developed the industry's first-of-its-kind quick reference guide for use as a tool by first responders at the scene of an accident. The guide:

- *Is derived from information provided by manufacturers' emergency response guides*
- *Detailed vehicle-specific information such as identification mechanisms, disconnect procedures, and special concerns*
- *Can be used in an efficient manner so there is no confusion on the scene.*

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Equipment and Gear

- Specialized Equipment:
  - Nonstatic equipment and tools
  - Fire extinguishers (dry chemical or carbon dioxide)
  - Fire blanket
  - Broom
- Also recommended:
  - Thermal imaging camera (TIC)
  - Insulated hand tools

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Equipment and Gear

Personal Protective Equipment (PPE):

- PPE is needed for any incident involving gaseous fuels or gaseous fuel vehicles
- For catastrophic incidents, spills, or fires, a self-contained breathing apparatus (SCBA) is required

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Equipment and Gear

Structural Firefighters Protective Clothing

Firefighters responding to gaseous fuels incidents must wear the following SFPC:

- SCBA meeting NFPA 1981 requirements
- Protective ensemble meeting the applicable NFPA 1971 requirements
  - Turnout pants and coat
  - Flame retardant hood
  - Boots
  - Helmet
  - Face shield or goggles
  - Fire resistant or extreme low temperature gloves (LNG)

Structural firefighters protective clothing.
Source: DOE

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General Firefighting Measures

Propane:

- Has a low flash points
- Fires can be very difficult to suppress if burning for a sustained period
- Flames can burn in a strong wind
- Flames can be stretched out away from their source by many feet
- Concentrate on keeping the fire from spreading

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General Firefighting Measures

To extinguish a propane fire, first responders should:

- For small fires use dry chemical or carbon dioxide
- For large fires use water spray or fog
- Move containers from fire area if possible
- Ensure that the fire has been successfully suppressed
  - Remember that propane fires burn at very high temperatures and can smolder
  - These types of fires may continue to burn after it appears the fire has been successfully suppressed
  - Keep in mind if the flame is extinguished without stopping the fuel flow, the air / fuel mixture may reignite

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General Firefighting Measures

Vehicle Fires

To extinguish gaseous fuel vehicle fires, first responders should:

- If the fuel system can be isolated, put out the fire with traditional means
- If the fuel system cannot be isolated, let the fire burn
- Concentrate on keeping the fire from spreading into other areas or neighboring objects

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General Firefighting Measures

Station Fires

If there is a fire involving fueling of a gaseous fuel vehicle:

- DO NOT disconnect the nozzle from the vehicle fuel receptacle
- Evacuate the immediate area of the fire
- Activate the emergency shutdown device button
- If the fire is large, let hazmat contain it
- Get at least 3,000 feet away from the site as a container may rupture
- Keep away from the path of flames and vapors
- Eliminate sources of its ignition

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Tank Car and Trailer Fires

Tank Car and Trailer Fires:

- Fight fire from maximum distance or use unmanned monitors
- Cool containers by flooding with quantities of water until well after fire is out
- Withdraw immediately if:
  - Rising sound detected from venting safety devices
  - Tank discoloration
- ALWAYS stay away from tanks engulfed in fire
- For massive fires:
  - Use unmanned hose holders or monitor nozzles
  - If not possible, withdraw from area and let fire burn

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Extrication

- Before attempting a rescue:
  - Make sure the vehicle is not leaking fuel
  - Determine if dangerous vapors could ignite
- If passenger extrication is necessary, follow standard operating procedures
- Take care to consider possible leakage and/or vapors
- Also consider fuel system components

Hydraulic extrication tools.
Source: Hurst Jaws of Life

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Extrication

- If cutting is required, avoid critical components of the fuel system:
  - Fuel storage tank
  - Fuel lines
- NEVER cut or breach the airbag charge cylinders, any part of the fuel system, or the fuel storage tank
- Crib vehicles under the vehicle along the frame "pinch weld"
- DO NOT place cribbing under the fuel lines or fuel storage tanks

Firefighter using hydraulic extrication rescue tool set.

Source: NAFTC

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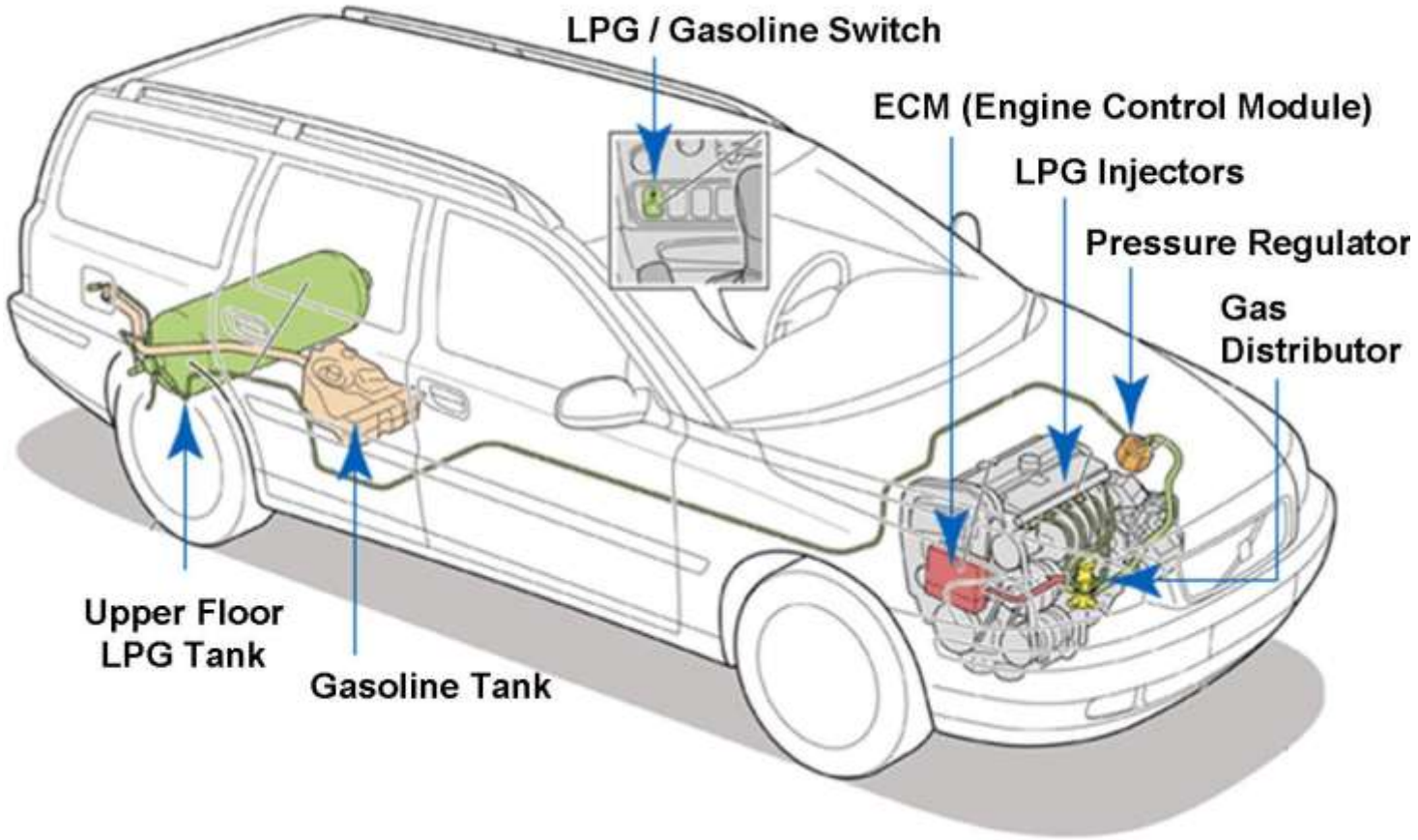
Extrication



Cutaway of LPG vehicle. Source: DOE

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Part 1 Discussion

Since completing Part 1, can you:

- List personal protective equipment (PPE) required when responding to a gaseous fuel-related incident?
- List the emergency procedures involving gaseous fuel storage, transport, distribution, and handling?
- List the steps required to secure a gaseous fuel vehicle during an accident?
- List the steps required when rescuing occupants from a damaged gaseous fuel vehicle?
- Demonstrate proper fire response to gaseous fuel fires regarding fueling stations, vehicles, and tanks?
- Demonstrate proper response to a gaseous fuel leak?

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First Responder Safety Training

- Liquefied Petroleum Gas and Liquefied Petroleum Gas Vehicles

www.nafte.wvu.edu/cleancitieslearningprogram

www.cleancities.energy.gov/

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