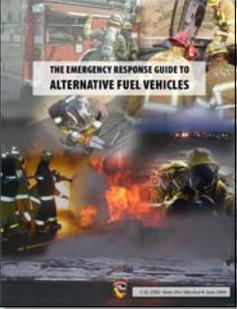


ALTERNATIVE FUEL EMERGENCY RESPONSE

The Emergency Response Guide to
Alternative Fuel Vehicles



CAL FIRE – STATE FIRE MARSHAL

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California Air Resources Board

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June 2009

The Emergency Response Guide to
Alternative Fuel Vehicles

Training Agenda

- INTRODUCTION
- INTERNAL COMBUSTION
- ELECTRIC VEHICLES
- EMERGENCY RESPONSE

INTRODUCTION

“Why are we dealing with alternative vehicles today?”



INTRODUCTION



Environmental Issues

Air quality and global warming is a factor in the proliferation of alternative fuel vehicles today

Traffic on the 405 freeway in L.A. is unmistakable with smog obscuring the background view



INTRODUCTION



Environmental Issues

Water Quality- Storm runoff from city streets with large amounts of motor oil, antifreeze, hydraulic fluids and spilled fuel dumped on the street account for a majority of water pollution today!



INTRODUCTION



Government Regulation

In 1990, California establishes zero emission mandates for vehicle manufacturers

In 1992, Congress approved and the President signed the National Energy Policy Act

- A national goal to reduce petroleum consumption
- Through tax incentives



INTRODUCTION



Energy Diversity
Supply of crude oil is expected to continue its decline in the next decade
Diversifying our energy resources ensures that we are not dependent on foreign oil supply

Purchasing foreign oil puts American dollars in the hands of those who want to destroy the American way of life.



INTRODUCTION



“Alternative Energy is a Homeland Security Issue!”

Matt Bettenhausen, Director
California Emergency Management Agency



INTRODUCTION



Research & Development
Industry innovation and new technologies provide the impetus for alternative vehicles

A 1912 Detroit Electric Car and the Phoenix Motorcars all electric truck



INTRODUCTION



Top: Honda Fuel Cell (concept), Ford F-150 Propane, Toyota Prius Hybrid
Bottom: Phoenix SUV, Chrysler Caravan Flex Fuel, Honda CNG



INTRODUCTION



Alternative energy vehicles include a variety of fleet vehicles; buses, street sweepers, refuse, long and short haul trucks.



INTRODUCTION



Environmental Issues

Alternative fuels like, ethanol, biodiesel, natural gas, propane, and hydrogen, along with electric, hybrid electric and fuel cells are emerging in response to these environmental/social issues.

Tesla Roadster
a member of the
new generation of
all electric vehicles



INTRODUCTION

Program Goal
To provide emergency responders with alternative fuel information so that they can make informed decisions at the scene of a vehicle emergency.

Objectives

- Insure Safety!
- Spotlight Hazards
- Validate Standard Operating Guidelines



INTRODUCTION

Instructor/Student Introductions

What are your expectations for this class?

Safety Plan

- Operating Procedures:
- Location of Exits:
- Emergency Notification Phone Numbers:
- Location of First Aid Equipment:
- Location of Medical Facilities:



The Emergency Response Guide to
Alternative Fuel Vehicles

Training Agenda

- INTRODUCTION
- INTERNAL COMBUSTION
- ELECTRIC VEHICLES
- EMERGENCY RESPONSE

INTERNAL COMBUSTION

OBJECTIVE

- Identify vehicles that use alternative fuels such as: ethanol, biodiesel, natural gas, propane or hydrogen
- Identify the hazards associated with each alternative fuel
- Recommend extinguishing agent for each fuel type
- Cite specific health hazards of each fuel type



INTERNAL COMBUSTION



Introduction

This discussion of alternative fuels, begins with your own knowledge and background of internal combustion engines



INTERNAL COMBUSTION

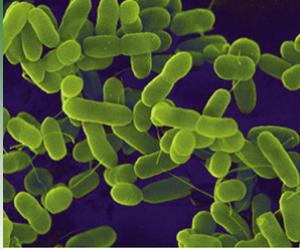


Higher fuel prices have driven people to search for less expensive alternative fuel sources

Ethanol, Biodiesel, Natural Gas, Propane, and Hydrogen fuels are all becoming viable options . . .



ETHANOL FUEL

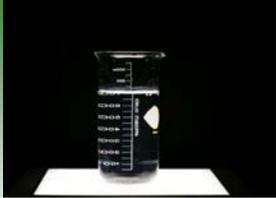


Ethanol can be produced from any biotic material like sugarcane and corn

Researchers are investigating the use of algae and e. coli bacteria as potential feedstock



ETHANOL FUEL



Ethanol Properties

- Clear Liquid
- Slight Gasoline Odor
- Water Soluble
- Electrically Conductive



ETHANOL FUEL



Ethanol Properties

- Flammable Range: 3% to 19%
- Auto Ignition Temp: 793°
- Reacts with: heat, oxidizing material; nitrates, peroxides, acids
- Combustion Produces: carbon monoxide, carbon dioxide, aldehydes, ketones



ETHANOL FUEL



Health Effects

- When inhaled or ingested may produce central nervous system depression characterized by headaches, nausea, dizziness, loss of balance and coordination, and stupor
- Vapors or spray mists may be irritating to nasal and respiratory tract
- Product may be irritating to skin and eyes resulting in redness, itching or burning
- Aspiration of ethanol can induce chemical pneumonia



ETHANOL FUEL



Vehicle Identification

Flex Fuel Insignia/Yellow Gas Cap



Vehicle Operation

Standard for ICE vehicles



ETHANOL FUEL



Vehicle Refueling

- Tanker truck delivered
- Underground storage
- Standard Pump Island
- Standard Station Safeguards





ETHANOL FUEL

Emergency Response

- E-85 fires are hard to see in the daylight
- Use thermal image camera to identify flames
- Use only Alcohol Resistant AFFF

BIODIESEL FUEL

Biodiesel Properties

- Non-Toxic
- Biodegradable
- Renewable
- Carbon Neutral
- Sulfur Free
- Produced Domestically

BIODIESEL FUEL

Health Effects

Acute oral lethal dose is greater than 17.4 g/Kg body weight

A 24-hr. human patch test with undiluted biodiesel produced a very mild irritation

BIODIESEL FUEL



Biodiesel has a specific gravity of 0.88 slightly lighter than water

Environmental Effects

Studies show that a 96-hour lethal concentration for bluegill of biodiesel grade was greater than 1000 mg/L.



BIODIESEL FUEL



Biodiesel Properties

- Yellow Liquid
- Smells like cooking oil
- Pure Biodiesel (B-100) refined from domestically grown crops, soybean, canola, rapeseed, and palm trees or recycled vegetable oil



BIODIESEL FUEL



Biodiesel Properties

- Biodiesel blended with diesel fuel to reduce exhaust emissions
- Degrades 4X faster than petroleum diesel
- Adding biodiesel accelerates diesel degradation

Rio Rico F.D., Arizona produce and use biodiesel in their department apparatus



BIODIESEL FUEL



Biodiesel Properties

- Flashpoint of biodiesel is 266°
- Flashpoint petroleum diesel 125°
- The flash point of biodiesel blends increases as the percentage of biodiesel increases



BIODIESEL FUEL



Vehicle Refueling

- Tanker truck delivered
- Underground storage
- Standard Pump Island
- Standard Station Safeguards



BIODIESEL FUEL



Nissan is releasing the Maxima with a diesel engine

Vehicle Operation

- Biodiesel can be used in any vehicle that uses diesel
- No special insignia required
- No special technique for vehicle operation



BIODIESEL FUEL

Biodiesel Emergencies

- Extinguish fires with dry chemical, foam, CO2, water (fog) spray
- Remove sources of ignition
- Stop leak, when safe to do so
- Biodiesel soaked material can spontaneously ignite, store in approved containers



NATURAL GAS



Natural Gas Benefits

- Nontoxic
- Non-corrosive
- Burns cleaner than other fuels
- High ignition temperature
- Narrow explosive range



NATURAL GAS



Natural Gas Benefits

- 80,000 miles of CNG pipelines
- 1,300 fueling stations statewide
- Abundant reserves of domestic natural gas



NATURAL GAS

Natural Gas Properties

- Naturally colorless and odorless
- Mercaptan added to detect leaks
- No exposure hazard
- Can displace O2 in confined spaces



Honda Civic CNGV 

NATURAL GAS

Natural Gas Properties

- Lighter than air
- Vapors from other fuels tend to pool on the ground
- Stored under high pressure 3600 psi
- Visible flame
- Flammable range 5% to 15%



Toyota Camry CNGV 

NATURAL GAS

CNG Identification









NATURAL GAS



Compressed Natural Gas Vehicle Operation

- Operates as a standard ICE vehicle
- Fuel regulator regulates fuel pressure to the engine
- Located near the fuel cylinder or near the engine



NATURAL GAS



CNG Refueling

CNG is delivered through an intricate network of pipelines to refueling stations

Pipeline delivered CNG must be filtered from impurities, dried, and compressed to 3,600 psi before it is pumped to consumer vehicles



NATURAL GAS



CNG Refueling

Storage tanks hold 10,000 cubic feet of product or 300 gallons

All retail facilities have safeguards:

- Break-away hoses
- Emergency shut-off
- Curb-side shut-off from the pipeline



NATURAL GAS



CNG Residential Refueling

- Designed to minimize vandalism and damage
- Systems can be indoor or outdoor
- Indoor installations require a gas detector



NATURAL GAS

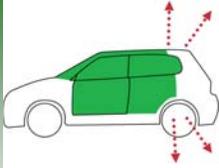


Cylinder Safety

- Types I, II, III, IV cylinder
- CNG, Propane and Hydrogen fuels use these cylinders
- Cylinders are design to withstand greater pressure than the rated capacity
- 3,600 psi cylinder is tested at 8,100 psi for example



NATURAL GAS



Cylinder Safety

- Cylinders are equipped with a pressure relief device (PRD)
- A vent tube is attached to the PRD to vent gas away from vehicle
- When cryogenic tanks are used (as in LNG or H2 liquid) do not get water into the vent tube as it will freeze and PRD will not operate properly



NATURAL GAS



Cylinder Safety

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The result of a Honda Civic NGV fire with a plugged PRD the cylinder flew several feet from the vehicle



NATURAL GAS



Cylinder Safety

- Fuel shut-off valves are located in the wheel well of many passenger vehicles
- For fleet vehicles the shut-off maybe clearly marked
- Consult Manufacturer information for specific location



NATURAL GAS



CNG Emergency Response

- Use gas detector to identify leaks
- Isolate fuel from ignition sources by shutting off fuel valves
- Allow fuel to burn itself out while protecting exposures

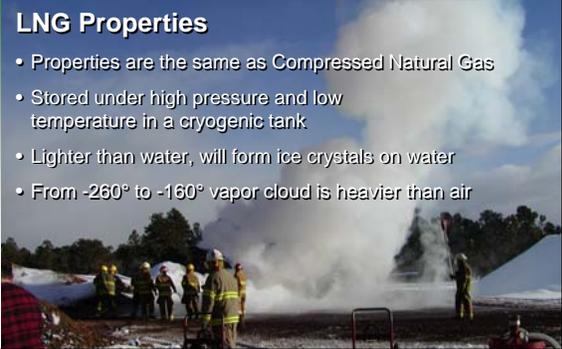
NATURAL GAS



CNG Emergency Response

- Use fog stream to direct vapor away from exposures
- Use water or foam to extinguish fire if necessary
- Avoid contact with high velocity jet of escaping gas
- Never walk through vapor cloud!

NATURAL GAS



LNG Properties

- Properties are the same as Compressed Natural Gas
- Stored under high pressure and low temperature in a cryogenic tank
- Lighter than water, will form ice crystals on water
- From -260° to -160° vapor cloud is heavier than air

NATURAL GAS



LNG Advantages

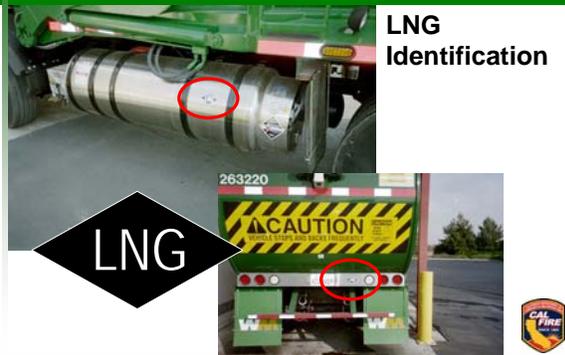
- Lower level of impurities
- Lower storage pressure at 230 psi
- Greater storage density 2-3 times more than CNG
- Stored in a thermos like tank



Bonfire test of a H2 tank

ALTERNATIVE FUEL EMERGENCY RESPONSE

NATURAL GAS



LNG Identification

263220

CAUTION

LNG

CAL FIRE

The image shows two photographs related to LNG identification. The top photo shows a close-up of a silver LNG storage tank with a red circle highlighting a specific label. The bottom photo shows the rear of a green waste management truck with a yellow and black hazard diamond on the back that says 'CAUTION' and 'LNG'. A red circle highlights the 'LNG' label on the diamond. A 'CAL FIRE' logo is in the bottom right corner.

NATURAL GAS



LNGV Operation

- Operation is the same as any similarly fueled vehicle
- Turning off ignition stops the flow of fuel
- Chock wheels- stabilize the vehicle from moving

CAL FIRE

The image shows the interior of a vehicle's cab, focusing on the steering wheel and dashboard. A 'CAL FIRE' logo is in the bottom right corner.

NATURAL GAS

LNG Refueling

- Delivered by tanker truck
- Tanker truck capacity is 10,000 gallons
- Tanker transfers to on site storage tank



CAL FIRE

The image shows a green waste management tanker truck parked in front of a large blue storage tank. The truck has 'WM' on its side. A 'CAL FIRE' logo is in the bottom right corner.

ALTERNATIVE FUEL EMERGENCY RESPONSE

NATURAL GAS



LNG Refueling

Cryogenic liquid will cause burns and frostbite on contact

Trained operator protected with rubber apron, gloves and face shield

NATURAL GAS



LNG Refueling

Frost around valves is normal!

NATURAL GAS



LNG Refueling

Frost on the outside of the tank indicates tank failure

The PRD on LNG systems re-seat themselves after pressure is relieved

ALTERNATIVE FUEL EMERGENCY RESPONSE

NATURAL GAS



LNG Emergency Response

- Use high volume Purple K to extinguish LNG fire
- Use high expansion foam on the surface of LNG fire
- Avoid contact with LNG liquid

NATURAL GAS



LNG Emergency Response

- Never walk through vapor cloud!
- Use sand or dirt berms to keep from entering storm drains

PROPANE



- Propane gas and Liquefied Petroleum Gas (LPG) is the third most common vehicle fuel
- The largest number of vehicles are used in fleet operations
- Clean burning
- Safer than gasoline (slower burning and higher ignition temperature)



PROPANE



Propane Properties

- Contains 90% propane and 10% of other gases
- 70% is processed from natural gas 30% from crude oil extraction
- Colorless
- Odorless (Mercaptan added)



PROPANE



LPG Properties

- At 200 psi and 70°F shrinks to a liquid 270 times more dense than it was as a gas
- Boiling point is -44°
- Liquid expands rapidly 1.5 times for every 10 degree rise in temperature
- This dynamic creates the potential for a BLEVE



PROPANE



LPG Properties

- B**oiling
- L**iquid
- E**xpanding
- V**apor
- E**xplosion



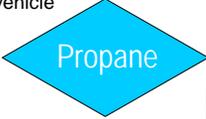
PROPANE



Vehicle Identification
Diamond on rear of vehicle



Vehicle Operation
The same as any other ICE vehicle



PROPANE



Vehicle Refueling

- Fuel delivered by tank truck
- Above ground storage
- Trained technician refuels
- LPG pumped to the vehicle under 200 psi pressure
- Filled to 80% to allow for expansion



PROPANE



Emergency Response

- Do not approach propane tanks from their ends approach from the side
- Approach propane vehicles at a 45° angle with an extended and charged hose line
- Direct water to the top of tanks
- Use gas detectors to determine leaks



PROPANE



Emergency Response

- Isolate fuel from potential ignition sources
- Allow fuel fire to burn itself out while protecting exposures
- Use foam or water to extinguish fire when necessary
- Never walk through vapor cloud!



HYDROGEN



Hydrogen Benefits

Currently, there are over 200 hydrogen powered vehicles on the road in California

Most in major metropolitan areas like Los Angeles, San Diego, San Francisco and Sacramento



HYDROGEN



Hydrogen Benefits

- No color or odor
- Nontoxic
- Disperses quickly
- Combustion produces water and heat

Three times the energy content per pound than gasoline



HYDROGEN



Hydrogen Properties

- Compressed gas 2,400 PSI
- As a cryogenic liquid below -253°C
- One and Half million cubic feet of liquid hydrogen can be stored in the same space as 100,000 cubic feet of hydrogen gas



HYDROGEN



Hydrogen Properties

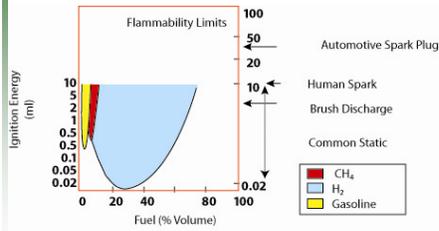
- Self ignition temperature 550°C
- Flames invisible in day light
- Thermal image camera needed to see flame plume
- Like any gas, can displace oxygen creating an asphyxiant hazard in confined spaces

Mazda's rotary hydrogen fueled engine recharges the battery pack as a hybrid electric vehicle



HYDROGEN

Hydrogen Flammability



Flammability Limits

Ignition Energy (mJ)

Fuel (% Volume)

Flammability Limits of H₂ Are Seven Times Wider Than CH₄

Automotive Spark Plug

Human Spark

Brush Discharge

Common Static

CH₄

H₂

Gasoline



HYDROGEN

Hydrogen Flammability

Property	Hydrogen	Propane	Gasoline	Natural Gas
Ignition Energy Mj/g	20	250	250	300
Lower Limit	4%	2%	1%	5%
Upper Limit	75%	10%	8%	15%



HYDROGEN



H² Identification



Liquid Hydrogen

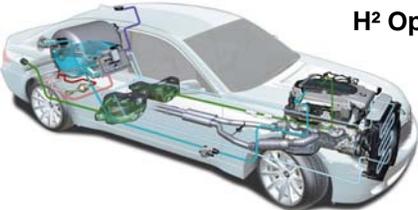




Compressed Hydrogen



HYDROGEN



H² Operation

- Operates the same as any ICE vehicle
- Shut-off engine with key
- Set parking break and chock wheels



HYDROGEN



H² Operation

- Insulated tank holds 18 pounds of liquid H²
- Tank design is equal to 57 feet of insulation material
- In 9 days 1/3 of liquid H² becomes water vapor
- Parking in enclosed spaces not an option



HYDROGEN



H² Operation

Tank is tested per standards

- Environmental Pressure
- Pressure Cycle
- Bonfire
- Gunshot
- Burst
- Drop



HYDROGEN

H² Vehicle Safety

- Remotely Monitored - GPS Signal
- Pressure Relief Openings
- Driver Warning Systems
- Gas Detectors



HYDROGEN

H² Vehicle Safety



Gas Detector

Driver Warning Systems



Warning: malfunction in H2 system

Remotely Monitored



Warning: malfunction in hydrogen system.
Stop at a suitable location.
Please contact BMW Customer Support as soon as possible.

HYDROGEN



D 830 D 820 D 810

H² Refueling

- More stations in the planning and development process
- Some produce Hydrogen on site
- Some use tanker truck deliveries
- Stored in above ground tanks



HYDROGEN



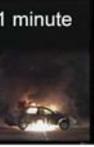
sersto

TOTAL

H² Refueling



HYDROGEN

Hydrogen	Gasoline
	
3 seconds	
	
1 minute	

H² Emergencies

- Eliminate ignition sources
- Flames are invisible in daylight
- Use infra-red detector or thermal imaging camera
- Do not extinguish
- Allow fuel fire to burn itself out
- Protect exposures



Different Risk Between Hydrogen and Gasoline (Catherine E)

HYDROGEN



H² Emergencies

Extrication use roof fold
"C" Pillars have vent tubes you do not want to cut!
Standard extrication access other than the undercarriage where fuel lines are located



The Emergency Response Guide to Alternative Fuel Vehicles

Training Agenda

- INTRODUCTION
- INTERNAL COMBUSTION
- ELECTRIC VEHICLES
- EMERGENCY RESPONSE

ELECTRIC VEHICLES

OBJECTIVE

- Identify electric, hybrid electric and fuel cell vehicles
- Distinguish the hazards associated with each vehicle type
- Recommend extinguishing agent for each battery type
- Name the components of an electrically powered vehicle



ELECTRIC VEHICLES

EV Introduction



Electric vehicles competed against ICE vehicles 100 years ago, today they are staged to make a significant come back!



ELECTRIC VEHICLES

EV Introduction



The promise of an all electric vehicle option was kept alive with the neighborhood electric GEM vehicle and the all electric Bad Boy Buggy ATV



ELECTRIC VEHICLES

EV Introduction



Today, the future is looking good for freeway driving in full size electric vehicles due to advanced battery technologies



ELECTRIC VEHICLES

EV Benefits



Electric vehicles improve air quality

No tailpipe emissions

New battery technologies increase vehicle range between charges

Batteries are charging faster!



ELECTRIC VEHICLES

EV vs. ICE

Electric Motor	Combustion Engine
Battery Pack	Fuel Tank
Electric Control Module	Electronic Ignition
High and Low Voltage	Low Voltage System
No emission	Emission Issues

Hybrid Electric Vehicles



ELECTRIC VEHICLES



EV Identification

- ZEV or EV decals and insignia on the rear of the vehicle
- Demonstration vehicles are clearly marked



ELECTRIC VEHICLES



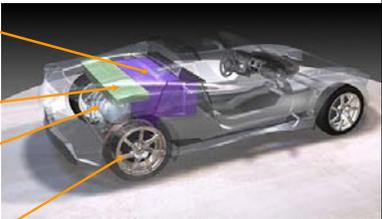
EV Operation

- Electronic key or keypad is used to start and shut down
- Operates quietly



ELECTRIC VEHICLES

EV Operation



- Electronic Control Module (Inverter/converter)
- Battery Pack
- Electric Traction Motor
- Regenerative Brakes



ELECTRIC VEHICLES



Electronic Control Module
ECM is High Voltage!
Accelerator pedal sends electric signal to ECM
ECM regulates the amount of current to the motor

EV Operation



ELECTRIC VEHICLES



Battery Pack and Battery Management System

- Provides electrical power to engine and controls charging and overcharging
- High Voltage!

EV Operation



ELECTRIC VEHICLES



Regenerative Brakes
Converts kinetic energy into electricity replenishing the battery pack

EV Operation



ELECTRIC VEHICLES

Lead Acid Batteries

- Liquid sulfuric acid electrolyte solution in flooded cell designs
- Advanced valve regulated can immobilized in absorptive glass mat, or suspended in a gel
- The electrical potential between electrodes is about 2 volts
- Advanced batteries have eliminated off-gassing



ELECTRIC VEHICLES

Lead Acid Battery Fire



- Batteries will generate corrosive gases when heated
- Extinguish with CO2, foam, dry chemical
- Sealed batteries can be crushed up to 60% before electrolyte is spilled
- Cover spilled electrolyte with dry sand



ELECTRIC VEHICLES

Lead Acid Battery Configuration



- Flooded lead acid batteries used in mass transit
- Advanced lead acid battery systems also in mass transit and early HEV technologies



ELECTRIC VEHICLES

Nickel Metal Hydride Batteries

- Sulfuric NMH electrolyte is a base
- Battery is sealed like the advanced lead acid batteries
- The nominal cell voltage for NMH batteries is 1.2 volts
- NMH is more tolerant of overcharge and over discharge



ELECTRIC VEHICLES

Nickel Metal Hydride Battery Fire

- Extinguish with Class D fire extinguisher (metal X or similar)
- Electrolyte is extremely corrosive to human tissue
- Reacts violently with organic chemicals
- Contact with metals may produce flammable hydrogen gas



ELECTRIC VEHICLES

Nickel Metal Hydride Battery Configuration



Ford Escape HEV

- NMH Battery pack in the rear storage compartment
- Many HEV currently use NMH



ELECTRIC VEHICLES

Lithium Ion Batteries

- Lithium is highly reactive with liquid electrolytes
- Lithium ions charge and discharge faster
- Battery produces 1.2 volts per cell
- Battery is 40 percent smaller which allows for twice as many batteries, doubling the energy storage, increasing range



ELECTRIC VEHICLES

Lithium Ion Battery Fire

- Use water or foam on vehicle fires
- Extinguish lithium battery fire with dry chemical, CO2, as a last resort- water spray or regular foam
- Do NOT penetrate battery pack – High Voltage



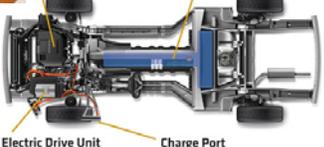
ELECTRIC VEHICLES

Lithium Ion Battery Configuration



Chevy Volt

- New Generation Hybrid Electric
- ICE generates electricity to recharge battery pack, vehicle operated in all electric mode



Engine Generator Lithium-Ion Battery



Electric Drive Unit Charge Port

ELECTRIC VEHICLES

Vehicle Recharging



Solar is used at this recharging station to supplement grid power

Inductive charging used in the EV-1 below



Three levels of charging defined in the Electrical Codes



ELECTRIC VEHICLES

EV Safety

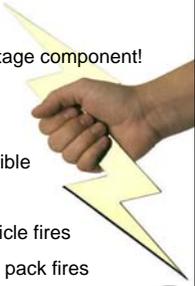


- Orange cables denote High Voltage– do not cut!
- Inertia switches and pilot circuits will shut down High Voltage
- It takes approximately 5 minutes for the energy to dissipate
- It is safe to work with submerged vehicles



ELECTRIC VEHICLES

EV Emergencies



- Do not penetrate or cut any high voltage component!
- Avoid wearing jewelry
- Wear Full PPE
- Use insulated hand tools when possible
- Locate manual disconnects
- Use water or foam to extinguish vehicle fires
- Use recommended agent for battery pack fires



HYBRID ELECTRIC



HEV Benefits

- Combines ICE and EV technology
- Refueling infrastructure in place
- Fewer carbon emissions
- Quiet Operation



HYBRID ELECTRIC



HEV Identification

- Hybrid insignia
- Inverter/Converter under the hood



Honda Civic
Insignia, Battery Pack and
Engine/Motor Compartment



HYBRID ELECTRIC



HEV Operation

- Electric key or power button shuts down vehicle
- Standard parking brake
- Identify vehicle idiosyncrasies in owners manual

HYBRID ELECTRIC



Plug-In HEV's

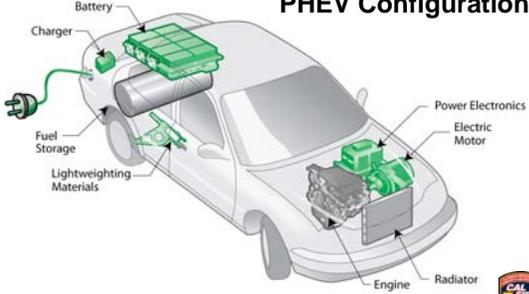
Currently HEV's recharge while the vehicle is operating eliminating the need for an external charge

- An additional battery pack and charging port turns an HEV into a PHEV
- PHEV's extend the mileage and range of the vehicle



HYBRID ELECTRIC

PHEV Configuration



Labels in diagram: Battery, Charger, Fuel Storage, Lightweighting Materials, Engine, Radiator, Electric Motor, Power Electronics



HYBRID ELECTRIC

HEV Adaptations

All Electric or Hybrid?

- Chevy and Mazda uses ICE to generate electricity but not to power the drive train



HYBRID ELECTRIC



SOLAR HEV

- Currently an after market application for Prius and soon other HEV's
- Will add 20 to 30 miles in range
- Toyota is adding photovoltaic panels (PV) to power A/C systems
- Pinarina includes solar in their roll-out
- Only generates electricity when the sun is shining!



HYBRID ELECTRIC BUS

Hybrid electric buses use ICE and electric motor
Small 22-foot shuttles to full size transit buses
Battery compartments are smaller than all electric buses



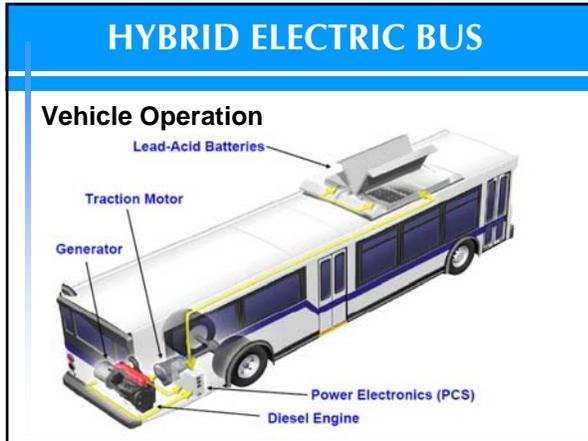
HYBRID ELECTRIC BUS

Vehicle Identification

Hybrid electric buses are clearly marked to take advantage of the positive publicity they generate.



ALTERNATIVE FUEL EMERGENCY RESPONSE



HYBRID ELECTRIC BUS

Fuels

Hybrid buses can use a variety of fuels

Diesel engines are prevalent

Biodiesel can be used as an alternative

Natural gas cylinders typically mounted on the roof

Separation of fuel tanks and electrical components insure that sparks do not ignite fuel

HYBRID ELECTRIC BUS

Hybrid Vehicle Emergencies

Responders have both electrical and fuel systems to mitigate

Water is the recommended agent for vehicle fires

Fuel and battery chemistries may require specific suppression agents

Some vehicles may have more than one 12 volt battery system

ALTERNATIVE FUEL EMERGENCY RESPONSE

FUEL CELL VEHICLES

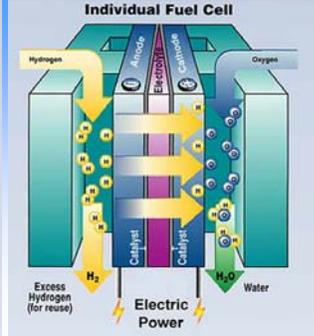


Fuel Cell Benefits

- Zero Emissions
- Quiet Operation
- Energy Efficient
- Energy Diversity



FUEL CELL VEHICLES



Fuel Cell Technology

Automakers use Proton Exchange Membrane Fuel Cell

Hydrogen gas is essential to the process



FUEL CELL VEHICLES



FCV Identification

Compressed Hydrogen

Liquid Hydrogen

FUEL CELL VEHICLES



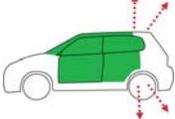
Vehicle Operation

Drives like ICE counterpart

Vehicles have both low and high voltage systems

When heated, the H2 tank has a combination pressure relief device and a temperature relief device (PRD/TRD)

PRD/TRD releases with a bang followed by a loud hiss



FUEL CELL VEHICLES

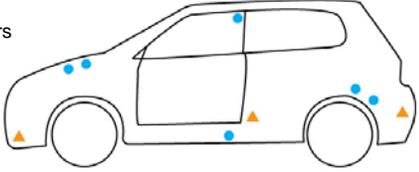
Vehicle Operation



FUEL CELL VEHICLES

FCV Safety

- H2 sensors
- Impact sensors
- PRD/TRD
- Fire Suppression System
- Emergency Shut Off Switch



● Hydrogen Sensor
▲ Impact Sensor



ALTERNATIVE FUEL EMERGENCY RESPONSE

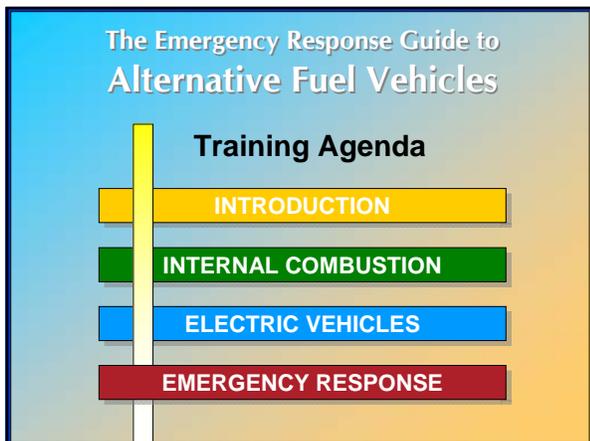


FUEL CELL VEHICLES

FCV Emergency



- Follow your SOG
- Pre-plan for emergencies by visiting transit yard and/or consulting manufacturers ERG
- Listen for leaking H2
- Let H2 fires burn
- Do not cut high voltage components or wires



EMERGENCY RESPONSE

OBJECTIVE

- Apply alternative fuel/energy information to standard operating guidelines (SOG)
- Establish safety and organizational structure to alternative vehicle emergencies
- Identify specific hazards inherent in all vehicles



EMERGENCY RESPONSE



Vehicle Identification

Informed decisions can only be made once the vehicle propulsion system is known

EMERGENCY RESPONSE

ALT-FUEL VEHICLE FIRE



EMERGENCY RESPONSE



Apply SOP to Alt-Fuel Vehicle Fires

- Park apparatus approximately 100 feet away from fire
- Approach from Upwind & Uphill
- 1 ¾" lines should be used as the minimum size attack line
- Approach all vehicles at a 45 degree angle to the vehicle

EMERGENCY RESPONSE

Safety & Organization



Who is in charge of vehicular emergencies?

EMERGENCY RESPONSE

Safety & Organization



The Extrication Team

Pin-ins require minimum of 10 team positions

Multiple pin-ins may require multiple teams

ALTERNATIVE FUEL EMERGENCY RESPONSE

EMERGENCY RESPONSE

Safety & Organization



The Team Leader
Will perform other team roles as positions are filled

Safety Officer
Team Leader performs until the position is filled

EMERGENCY RESPONSE

Safety & Organization



Nozzle Person
In the event that fire erupts, the first priority of the Nozzle Person is to immediately apply water in a fog pattern over the rescue site to allow rescuers to escape

EMERGENCY RESPONSE

Safety & Organization



Tool Operator
The Team Leader should use the most experienced tool operator for live rescues

EMERGENCY RESPONSE

Safety & Organization



Operator-Back-Up
Serve as the immediate safety back-up for tool operator

EMERGENCY RESPONSE

Safety & Organization



Staging Manager
Keeps tools and equipment organized, oversees tool set-up

EMERGENCY RESPONSE

Safety & Organization



Team Assistants
Valuable asset to any team operation in that they can assist EMS or fetch tools and equipment

ALTERNATIVE FUEL EMERGENCY RESPONSE

EMERGENCY RESPONSE

Safety & Organization



Personal Protective Equipment
Turnout Pants & Coat
Helmet
Eye Protection
Boots
Leather Gloves
SCBA

EMERGENCY RESPONSE

Operational Safety



Protection from Traffic
Eliminate Ignition Sources
Stabilize Vehicles
Downed Power Lines
Additional Hazards

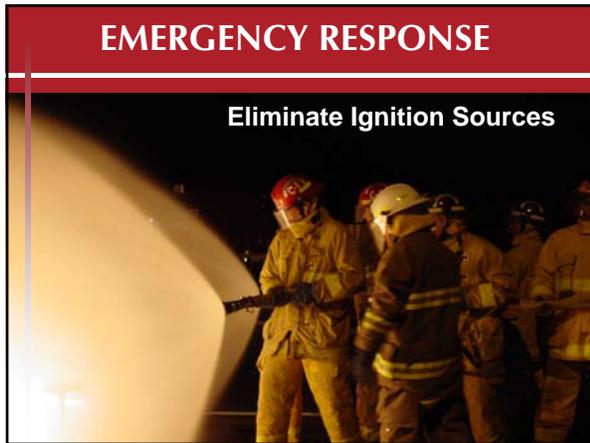
EMERGENCY RESPONSE

Protect from Traffic



ALTERNATIVE FUEL EMERGENCY RESPONSE







EMERGENCY RESPONSE



Power Lines

- Do not approach until power is confirmed to be shut-off.
- Damage at one location may drop lines in another location out of immediate view.

EMERGENCY RESPONSE



Additional Hazards

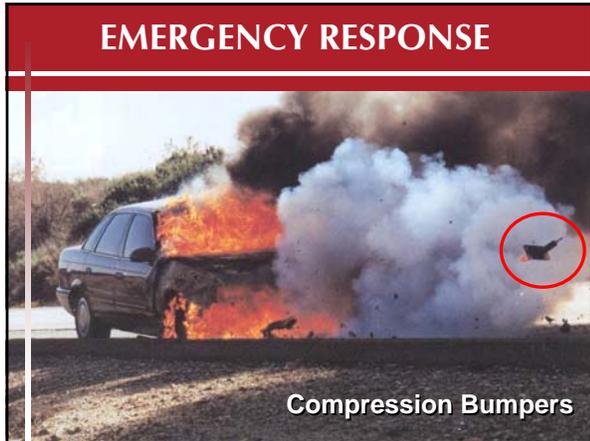
EMERGENCY RESPONSE

Additional Hazards



- Compression Bumpers
- 12 Volt Battery
- Suspension Systems
- Passive Roll Bar System
- Seat Belt Pretensioners
- Airbags

ALTERNATIVE FUEL EMERGENCY RESPONSE







ALTERNATIVE FUEL EMERGENCY RESPONSE

EMERGENCY RESPONSE



Pneumatic and Hydraulic Systems

EMERGENCY RESPONSE



Air Bags

EMERGENCY RESPONSE



Conclusion

Alternative transportation provides significant benefits to society

The challenge for us is to stay current with these technologies as they are developing
