

ALTERNATIVE FUEL VEHICLES

Components and Considerations

General Motors Hy-Wire



FUELS AND VEHICLES

FUELS

- **Bio-Derived Fuels**
- **Stored Hydraulic**
- **Compressed
Natural Gas**
- **Liquid Propane
Gas (LPG)**
- **Electricity**
- **Hydrogen**

FUELS



MDI One-CAT

**Operates on
Compressed Air at
4350psi**

**Uses ‘braking’ to re-
compress air**

**11 feet long, 3 or 6
seats, less than 1000
pounds**

**62 mile range; 496
miles with “air-heater”**



Fuel Additives

- **NOX** for gasoline
- Propane for diesels
- Towing/performance additive
- Fire/Crash related issues



...and now diesel has its own twist with “DEF”, which:

- Smells like ammonia
- Has a pH of 9.5
- May cause sore throat, sneezing, coughing, shortness of breath, and skin irritation.

•Should be absorbed with inert, non-combustible absorbent material if spilled.

•Gives off carbon oxides, nitrogen oxides, ammonia, biuret, cyanuric acid, and other irritating fumes and smoke during combustion.



32% Urea in water solution

Common Users

- **City/County/State Fleets**
- **Universities/Colleges**
- **Public Transportation**
- **School Systems**
- **Utility Companies**
- **Everyone Else!**









**E-85 FUELS POWERED
VEHICLES
(85% Ethanol in Gasoline)**

E85 Fuels



E85 Fuels

- **Flame is less bright than gasoline flame, but still visible in daylight.**
- **More flammable than gasoline at low temperatures.**
- **Ethanol mixes with water. Becomes a “polar/water-miscible flammable liquid”.**

E85 Fuels

- **For E-85: “UN1203” until 2010, then “UN3475”**
- **For E-95: “UN1987”**
- **NAERG: Guide 127, Flammable liquid, n.o.s.**
- **Use an alcohol-resistant foam to fight fires involving E85 fuel mixtures.**

STORED HYDRAULIC HYBRID

Stores hydraulic fluid under pressure during deceleration/stops.

Small engine runs a hydraulic pump to turn a motor or store the fluid under pressure

Releases stored hydraulic fluid to the drive train during acceleration.

Being tested in taxis, SUVs, trucks, busses, UPS, FedEx trucks.



STORED HYDRAULIC HYBRID

**Reduces fuel
consumption by up to
70%.**

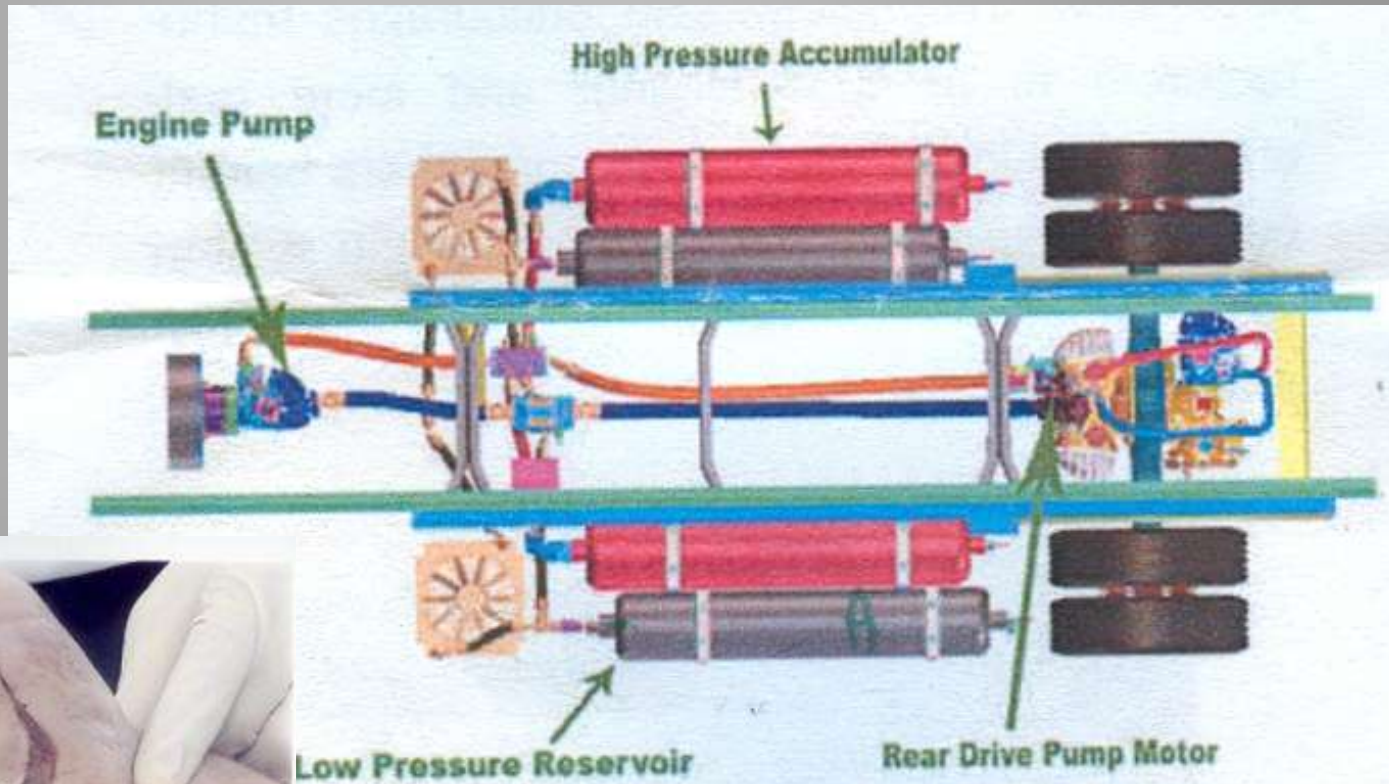
**(19mpg for UPS and 35 mpg
for Ford Expedition)**

**Can propel the vehicle
several hundred feet
without the
conventional engine.**



STORED HYDRAULIC HYBRID

Pressurized whenever the key is in the ignition – not just 'on'.



Low Pressure - ~200psi

High Pressure - ~5000-7000psi

STORED HYDRAULIC HYBRID

Garbage Trucks in Ann Arbor



COURTESY: CHRYSLER

**Chrysler
proposing a
minivan by 2012**

COMPRESSED NATURAL GAS

CNG Properties

- **CNG rated at 117 octane fuel**
- **BTU per # = 22,800 (gasoline = 18,900)**
- ***Not* a liquid when compressed (it becomes a very close dense gas)**
- ***Not* the same as Liquefied Natural Gas – LNG (cryogenic: -260° to become liquified)**
- **Lighter than air when released (.6 air)**

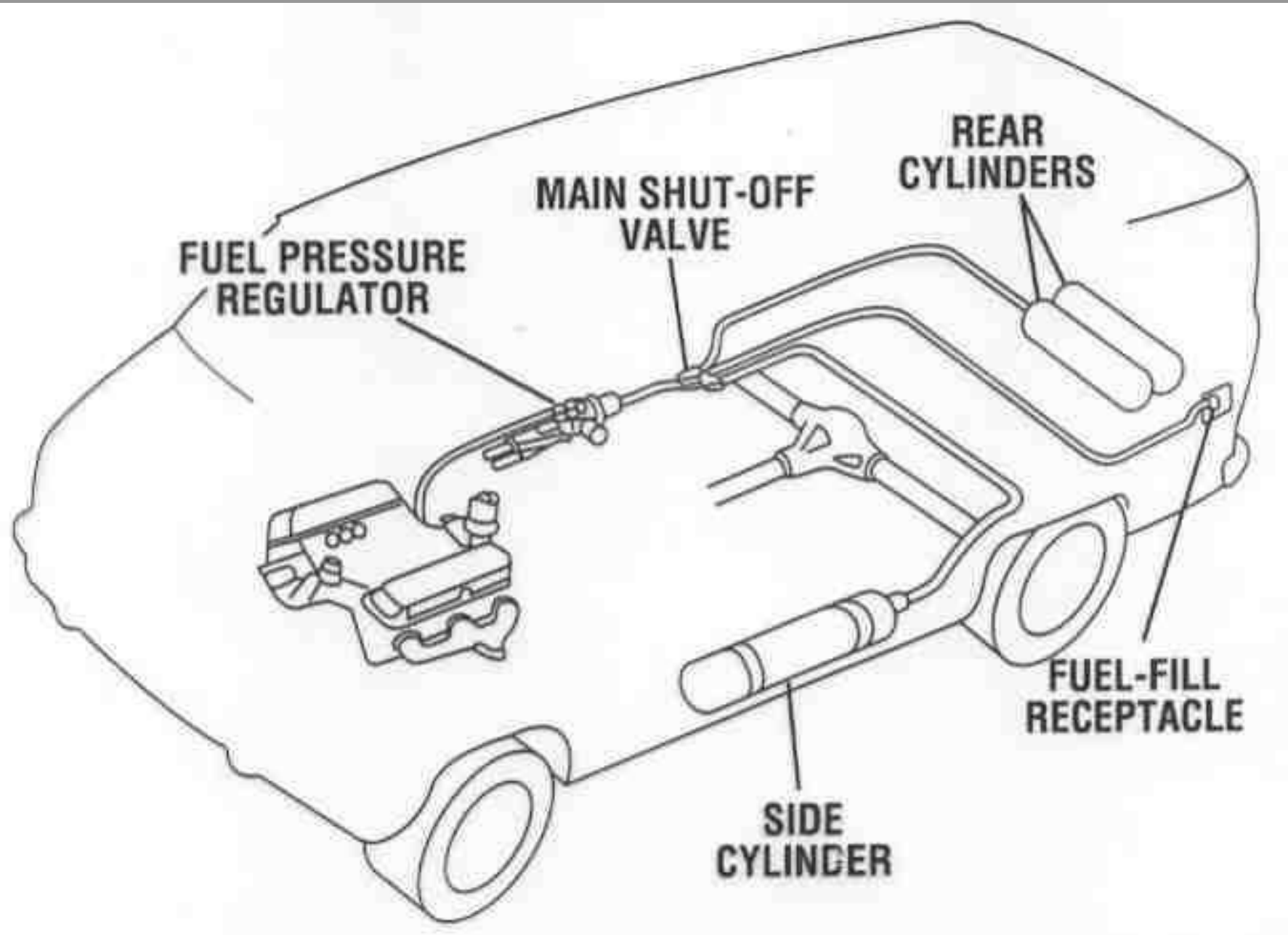
CNG Properties

- **LEL / UEL = 4 – 16% (gasoline = 1.3 – 7.6)**
- **1 cubic foot of CNG = 245 cu.ft. of natural gas at sea level (uncompressed)**
- **1 cubic foot of CNG weighs 13#**
- **5.66# = 1 Gasoline Gallon Equivalent (GGE)**
- **Honda Civic tank = 8 GGE**





Photo by
Ryan Lee
Harris County Hazmat



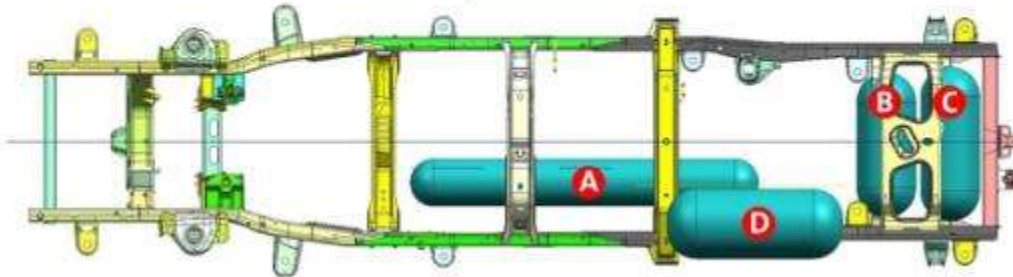


CHEVROLET EXPRESS



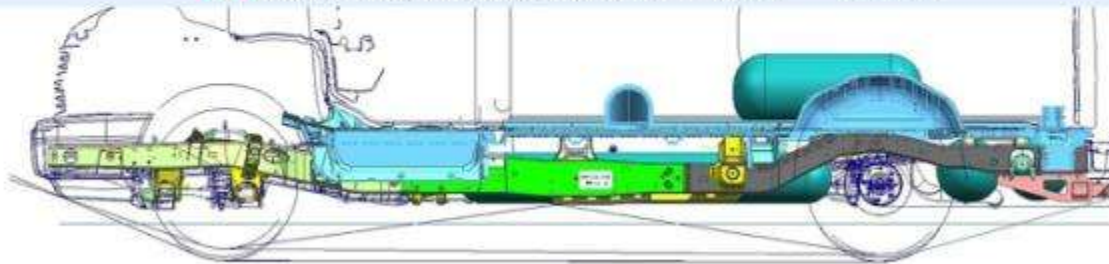
GMC SAVANA

CNG CARGO VANS: FUEL-EFFICIENT,
ENVIRONMENTALLY FRIENDLY



300+ Mile Range, 23 Gasoline Gallon Equivalent (GGE)

- A** Longitudinal, underbody (10.0" x 73") **6.4 GGE**
- B** Behind rear axle, underbody (13.2" x 31") **4.5 GGE**
- C** Behind rear axle, underbody (13.2" x 32") **4.9 GGE**
- D** Interior, cargo floor (optional, 15.4" x 39") **7.2 GGE**



Approach and departure angles and ground clearance provide increased safety



Cylinder Properties

- **Four Cylinder Types:**
 - **Type 1: all metal (steel or aluminum)**
 - **Type 2: hoop wrapped steel or aluminum**
 - **Type 3: fully wrapped steel or aluminum**
 - **Type 4: all-composite (non-metallic)***

***Early model Honda Civic uses Type 4;
later models use Type 3**



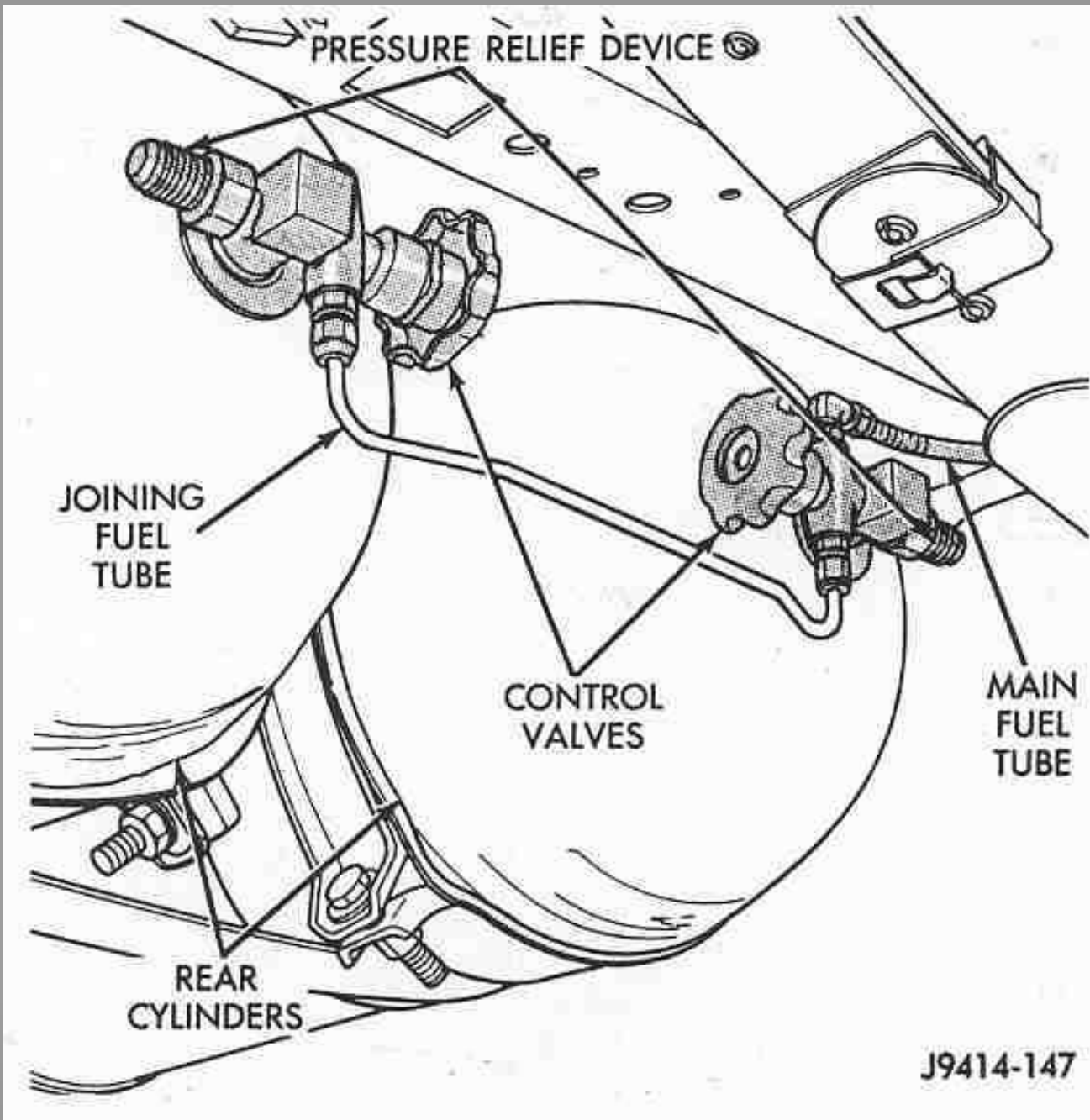


California
GASLIGHT
NATURAL GAS

FOR CHG ONLY

FOR CHG ONLY





J9414-147

Compressed Natural Gas Vehicle Fill Pressure Temperature Compensation Chart

Deg F	2400 PSI	3000 PSI	3600 PSI
100	2700	3400	4125
80	2490	3125	3775
70	2400	3000	3600
60	2300	2850	3425
40	2120	2600	3100
20	1900	2325	2750
0	1700	2075	2400
-20	1520	1800	2075

Caution: Do not exceed manufacturers rated vehicle fill pressure



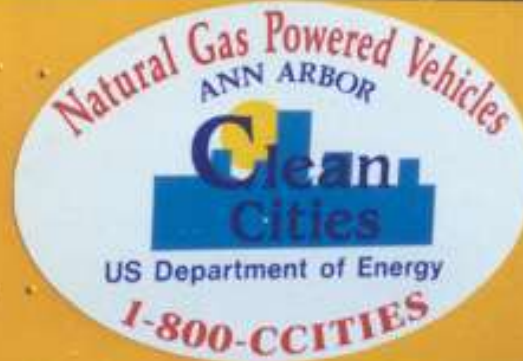




Fuel lines and fittings are tested to 4x their operating pressures.³⁷

SCHOOLS

MANUAL
SHUT-OFF
VALVE



FOR
•CNG
ONLY







CNG Rescue/Response

What are some appropriate steps to take when responding to and arriving at the scene of an accident involving a compressed natural gas powered vehicle?

CNG Rescue/Response

- **ID as an AFV (Markings, Fuel Ports, Cylinders, Gauges, Driver...commonly fleet vehicles like city/county/state, taxis, shuttles.)**
- **Communicate**
- **Chock wheels**
- **Set Brake**
- **Engage 'park'**
- **Turn Vehicle Off**

CNG Rescue/Response

- **Open Doors**
- **Turn Manual Fuel Shut-off Valve Off**
- **Turn Gas Cylinders Off**
- **Check for leaks and damage around tanks and system**

CNG Rescue/Response (cont)

- **Never cut any part of the fuel system**
- **Eliminate Sources of Ignition**
- **If fire starts, refer to “Fire Response” guide.**

CNG Fire Response



CNG Bus

Boise, Idaho

Venting System prevented explosion.

Extinguished approx. 15 minutes after initial call.



Historical Information

- Several NHTSA (National Highway Traffic Safety Administration) investigations
 - Example: January 27, 2003; Ford Crown Victoria on fire with flame impingement on CNG tank. The tank failed catastrophically prior to Pressure Relief Device (PRD) functioning.
 - Vehicle recall with dealers installing additional insulation behind back seat.
 - Number of vehicles still needing repair???



FIREFIGHTER NEAR MISS

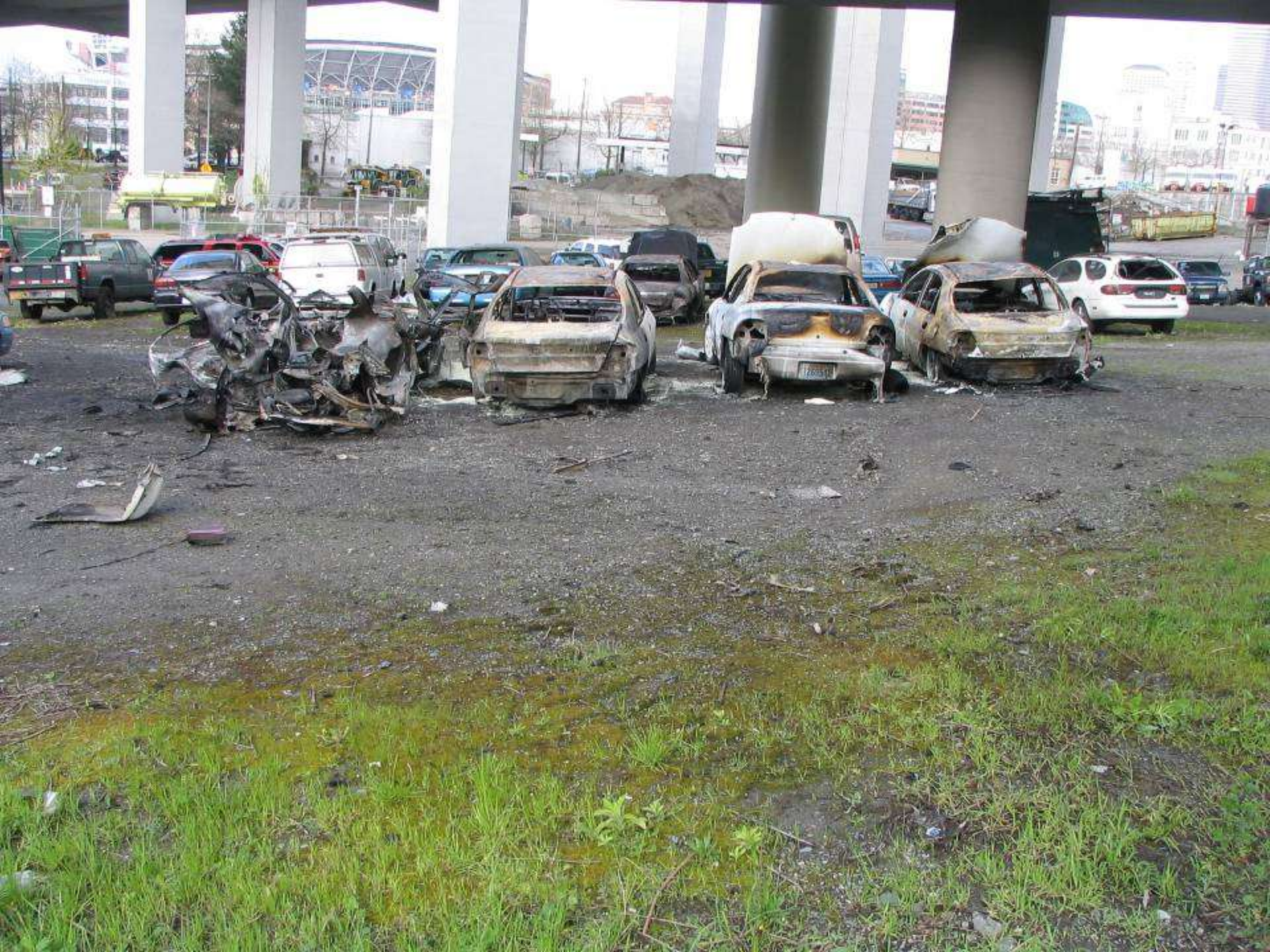
Auto Fire with Compressed Natural Gas (CNG) Fuel Tank Explosion

Prepared By Seattle Fire Department
Operations Division

April 2, 2007

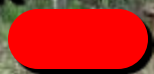
Arson: Incident #26564

- Dispatch 0230 hours for car fire (E10)
- E10 arrived and requested FIB for multiple vehicles with possible structural exposures (freeway columns and overpasses)
- 12 vehicles damaged or destroyed
- Firefighter near miss when CNG vehicle exploded as E10 crew approached with a handline (approximately 50-75' away)





**Tank landed here,
moved down hill to here
for extinguishment**





Composite tank is carbon-fiber / fiberglass wrapped for strength – similar to our SCBA tanks.

CNG Fire Response

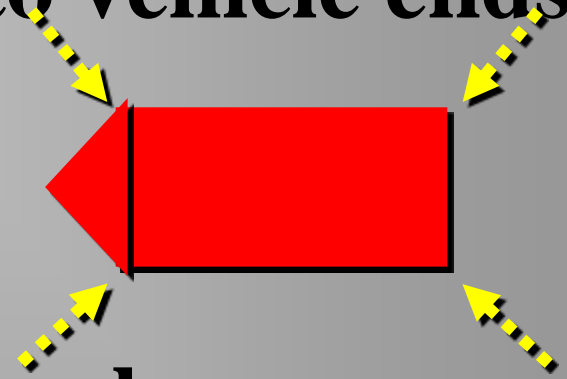
- **Prevent the fire.**
- **Follow “Rescue” response steps.**
- **Look for identifying logos/markings.**
- **Refer to MSDS and ERG guides.**

(Book)

- **Use normal extinguishing methods; but do not extinguish CNG flame.**
- **Be aware that PRD/TRD may open; Keep clear of vent. (approx. 212 deg F)**

CNG Fire Response

- Approach from 45° angle to vehicle ends



- Watch for other hazards, i.e. bumper struts; hood and tailgate struts; airbags; burning fuel runoff; hazardous vehicle contents; exploding tires; other traffic
- Consider cooling streams from a distance

PROPANE

**Very Similar to CNG – Much
Lower Pressure**



Metro Car

Used in construction and farming vehicles since the 1920's.
8/08 – Jack Rousch promotes fleet propane vehicle viability⁵⁶



DODGE

MICHIGAN
BND 2711

FASHION

- **Tanks – 3 to 300 gallon**
 - Manual Valves**
 - Automatic Shut-off Valves**
 - 240-312 psi rated pressure design**
 - 70 F = 132 psi vapor pressure**
 - 100 F = 205 psi vapor pressure**
 - 130 F = 300 psi vapor pressure**
 - Pressure Relief Valves set around 312 psi**
- **Lines – Carry Liquid Propane to Engine**
 - Excess Flow Check Valves**
 - Relief Valves set approx. 400-500 psi.**
 - Externally accessible shut off valve**



Schwann's started researching alternatives in the 1970's. By the 1980's most of the fleet had been converted.

Utilizes a Liquid Propane Electronic Fuel Injection system, with no evaporator.

Estimated fuel savings of over \$30 million annually.

Brandversuch LPG Autobus

BF-Wien

Activity 1:

List the “Rescue/Response” considerations, and the “Fire Response” considerations for vehicles powered by propane.

Propane Rescue/Response

- **ID as an AFV**
- **Communicate**
- **Chock wheels**
- **Set Brake**
- **Engage ‘park’**
- **Turn Vehicle Off**
- **Open Doors**

Propane Rescue/Response

- **Turn Manual Fuel Shut-off Valve Off**
- **Turn Gas Cylinders Off**
- **Check for leaks and damage around tanks and system**
- **Never cut any part of the fuel system**
- **Contact with liquid propane can cause frostbite**
- **Eliminate Sources of Ignition**

Propane Fire Response

- **Prevent the fire.**
- **Follow “Rescue” response steps.**
- **Anticipate other common vehicle fire hazards.**
- **Refer to MSDS and ERG guides.**
- **Use normal extinguishing methods; Cool from a distance; do not extinguish propane flame.**
- **Be aware that PRD/TRD may open; Keep clear of PRD vent.**

CHECK POINT DISCUSSION

**Lets go to a bus fire at the Park and Ride
lot at M-52 and I-94**

Think about:

- ✓ Size-up**
- ✓ Resources**
- ✓ Priorities**
- ✓ RECEO-VS**

VIDEO:

Bus Burns in Parking Lot

...a LOT of information.

Questions?

ACTIVITY 2: HANDS-ON REVIEW

**ACTIVITY 3:
TABLE-TOP DISCUSSIONS**



© WreckedExotics and their Respective Owners



**Car vs. Building
involving a ‘typical’
hybrid electric vehicle?
Size up?
Shut Down?
Patient Access?**





Small Groups

Scenario #2

Call: P.I. Accident, in a residential intersection in your area.

Time: 10:30 Saturday Morning.

Response: District Engine or Ladder Co.

You are dispatched to a P.I. at this intersection. When you arrive, you find that this car (Honda Civic GX) has been hit in the driver's side, rear quarter panel. The impact has pushed the quarter panel in approximately 10 inches and driver's door will no longer shut properly.

The driver of the car, Mr. Wilbur, states that he is sore but is quite anxious about the fuel tank in the trunk of the car. The driver of the other vehicle is standing over on the side of the road smoking a cigar, and states that he has no injuries.

As you approach the vehicle you can smell natural gas. The odor is strongest from under the vehicle. You locate a high-pressure tank securely mounted in the trunk of the car, but it has no external tank valve that you can turn.



Scenario #5

Call: Truck leaking fuel.

Time: 5:15 Saturday afternoon.

Response: One fire truck

When you arrive you find a brand new Chevrolet Tahoe, actively spilling fuel out from under the engine compartment. The fuel has formed a 10 foot diameter puddle, flowing slightly out toward the front of the truck. The temperature is 95 degrees, the truck is on asphalt, and the engine is running.

The owner, lights a Marlboro and exclaims that she just filled it up with that corn powered gasoline.





SWART

RESCUE