What Is a Typical CNG Vehicle?

The Maintenance of CNG Vehicles
CNG Vehicles
They Come In All Shapes and Sizes
CNG is a Proven Technology

Sedans, Pick-ups, Vans/Wagons
Honda
All GMC brands
Ford/Mercury/Lincoln via SVMs

Work/Vocational Trucks
Peterbilt, Freightliner,
Crane Carrier, Condor,
Isuzu, GM, Workhorse, Ottawa.....
Dozens of up-fitters in the work sector

Bus and Shuttle
NABI, Orion, New Flyer, Creative Bus,
El Dorado-National, Champion, Supreme,
Blue Bird, Thomas Built, Optima and Specialty
CNG Statistics

- Approximately 11 million NGVs in use worldwide; approximately 110,000 operating on US roads.
- Natural gas is compressed to enable the maximum onboard fuel storage.
  - 5.660 pounds = 1 Gasoline Gallon Equivalent (GGE) (≈125 scf)
  - 6.360 pounds = 1 Diesel Gallon Equivalent (DGE) (≈ 140 scf)
- Octane rating of 117
How is a CNG Vehicle Different Than a Diesel to Maintain?

- Engine Maintenance
- Fuel System Maintenance
- Fuel Cylinder Maintenance and Inspection
Engine Operation and Maintenance

- CNG engines operate in a similar way as a gasoline engine but at a higher temperature.
- Spark plugs or another ignition source are required for fuel ignition.
- CNG engines come in similar power and torque ranges as a gasoline or diesel engine.
- CNG is cleaner, extending the oil change intervals out substantially.
- Cummins ISLG oil and filter change intervals are 15,000mi/6mo or 500 runtime hours.
# ACUA CNG Scheduled PM Intervals

<table>
<thead>
<tr>
<th></th>
<th>Hours</th>
<th>Distance</th>
<th>Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil and Filter</td>
<td>500</td>
<td>15,000 mi</td>
<td>6</td>
</tr>
<tr>
<td>Spin-on Fuel Filter</td>
<td>1,000</td>
<td>15,000 mi</td>
<td>12</td>
</tr>
<tr>
<td>Spark Plugs</td>
<td>1,500</td>
<td>22,500 mi</td>
<td>18</td>
</tr>
<tr>
<td>Engine Coolant</td>
<td>2,000</td>
<td>30,000 mi</td>
<td>24</td>
</tr>
<tr>
<td>Overhead Adjustment</td>
<td>2,000</td>
<td>30,000 mi</td>
<td>24</td>
</tr>
</tbody>
</table>

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Fuel System Components and Maintenance

High Pressure 3600 psi max.
- Fill nozzle (O-ring)
- Tank pressure gauge
- Cylinder shutoff valve
- Pressure Relief Device
- Main shutoff valve
- High pressure filter (cartridge)
- Service vent
- Electric shutoff valve
- High pressure regulator

Low Pressure, Engine Supply
Approximately 100 psi
- Low pressure filter (cartridge)
- Electric shutoff valve
- Engine supply tubing and lines

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CNG Fuel System Details

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As a gaseous fuel, **CNG is lighter than air** and will rise quickly with no pooling on the ground as with other vehicle fuels.

- Tank(s) are specifically designed to quickly vent through a Pressure Relief Device (PRD) if enveloped in fire without rupturing the tank.
- There is a manual shutoff valve which can isolate each tank. Note: The PRD is still actively protecting the tank when the shutoff is closed.
- Electro-solenoid valves will also isolate the tank(s) and fuel system piping when the vehicle is turned off.
- An Excess-flow Valve on each cylinder prevents gas leakage in the case of a rapid pressure change past the cylinder.
# CNG Fuel Cylinder Types

## TABLE 1

A COMPARISON OF ONBOARD FUEL STORAGE CYLINDERS

<table>
<thead>
<tr>
<th>TYPE</th>
<th>SIZE</th>
<th>CAPACITY</th>
<th>WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>74&quot; x 15&quot;</td>
<td>1,820 SCF</td>
<td>387 lbs.</td>
</tr>
<tr>
<td>Example: All-Steel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 2</td>
<td>74&quot; x 15&quot;</td>
<td>1,820 SCF</td>
<td>290 lbs.</td>
</tr>
<tr>
<td>Example: Hoop-Wrapped Aluminum Composite</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 3</td>
<td>74&quot; x 15&quot;</td>
<td>1,820 SCF</td>
<td>141 lbs.</td>
</tr>
<tr>
<td>Example: Fully-Wrapped Aluminum Composite</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 4</td>
<td>74&quot; x 15&quot;</td>
<td>1,820 SCF</td>
<td>141 lbs.</td>
</tr>
<tr>
<td>Example: All-Composite</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Onboard 3600 psi vehicle cylinders; 4 types of onboard cylinders; all meet the same national safety standards FMVSS 304 and ANSI NGV2.

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Fuel Cylinder Design Type 3

- Lightweight aluminum liner.
- Precision-machined thread.
- Smooth, inert, corrosion-resistant internal finish.
- High-performance carbon-fiber overwrap in epoxy resin matrix.

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Fuel Types and Combustion Properties

Range of Flammability

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Lean Limit</th>
<th>Rich Limit</th>
<th>Flash Point</th>
<th>Auto Ignition Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel</td>
<td>0.60%</td>
<td>7.50%</td>
<td>145°F</td>
<td>420°F</td>
</tr>
<tr>
<td>Ethanol</td>
<td>3%</td>
<td>19%</td>
<td>55°F</td>
<td>690°F</td>
</tr>
<tr>
<td>Gasoline</td>
<td>1.40%</td>
<td>7.60%</td>
<td>&lt;-40°F</td>
<td>475°F</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>4%</td>
<td>75%</td>
<td>gas</td>
<td>930°F</td>
</tr>
<tr>
<td>Propane</td>
<td>2.2%</td>
<td>10%</td>
<td>gas</td>
<td>890°F</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>5%</td>
<td>16%</td>
<td>gas</td>
<td>1070°F</td>
</tr>
</tbody>
</table>
CNG Tank Safety

- Vehicle tanks and fuel systems should be inspected at least every 3 years/36000 miles or when the vehicle is in a motor vehicle accident
- Inspectors should be accredited by CSA Standards with a CNG Fuel System Inspector Certification
- CSA is recognized by the Occupational Safety & Health Administration (OSHA)
- American National Standards Institute (ANSI) NGV2
- Find an inspector at: http://peoplesearch-csa-america.org
Maintenance Center Precautions

- Released Natural Gas will pool in the ceiling of a service garage if not ventilated
- Exhaust fans and gas detection systems added
- Open flame heating sources eliminated
- Fleet technicians will need training on CNG
- Service safety procedures must be defined and followed by the fleet service technicians
- Gas leak detection service tools added
Staff Training Drivers

- Driver Training
  - Daily routines
  - Fueling procedures and safety
  - Use you ears and nose
Staff Training Mechanics

Mechanic Training

- Factory train your mechanics on the fuel system that is installed on your vehicles
- Require engine system training from manufacturer
- Cylinder manufacturers may also offer training
- Train on safe maintenance procedures associated with CNG: high pressure, venting methods and combustible safety
- Encourage and incentivize ASE certifications and other alternative fuel education
Training and Standards Organizations

- National Alternative Fuels Training Consortium (NAFTC)
- Natural Gas Vehicle Institute (NGVI)
- Clean Vehicle Education Foundation (CVEF)
- National Automotive Technician Education Foundation (NATEF)
- National Institute for Automotive Service Excellence (ASE)
CNG Fueling is Here at the ACUA

- ACUA built a CNG fueling station, partially funded by a DOE Clean Cities grant
- Station Dedicated in October 2010
- ACUA is committed to the full transition of its collection fleet to CNG
- Currently 5 CNG refuse trucks are operating, 10 more will arrive in the spring 2011
- First fleet accessible station in southern NJ, all fleets are welcome

Why CNG?

- Burns Cleaner
  80% less ozone forming emissions than diesel/gasoline vehicles
- Less Expensive
  Natural gas is between $0.50 and $1.00 cheaper than diesel per gallon equivalent
- Produced Domestically
CNG Cleaner, Cheaper and Better

QUESTIONS?
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