



Compressed Natural Gas (CNG) as an Automotive Fuel CNG 101

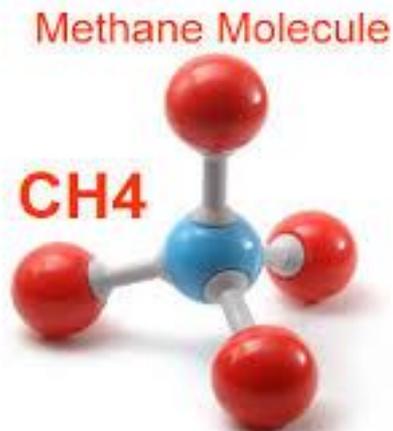
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**Green Your Fleet – Granite State Clean Cities
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What is natural gas?

Natural gas is a hydrocarbon-based fuel. It's a chemical compound and is 85% methane (CH₄) with one carbon atom and four hydrogen atoms. Methane is 80% hydrogen. Compared to other fuels transportation fuels, natural gas is very clean:

- Propane (LPG) – C₃H₈
- Gasoline – C₈H₁₈
- Diesel – C₁₄H₃₀



What is natural gas? (cont):

- Natural gas is primarily a domestic product. Over 98% of the natural gas supplies originate in North America. Natural gas is transported via the underground pipe infrastructure from the wells to the markets.
- The remaining 2% is imported as liquefied natural gas (LNG).
- Natural gas is lighter-than-air, non-toxic to breathe or touch, and cannot contaminate soil or groundwater.
- Natural gas is odorless and colorless. The interstate pipelines companies add an odorant. Many states require additional odorant.
- The historic uses of natural gas: street lamp lighting, space heating, water heating, cooking, drying, manufacturing, and electric power generation.



So what is CNG?

- Compressed natural gas or CNG is the compressed form of natural gas. So in reality - it is the same fuel consumers and businesses use for heating, hot water, drying, and cooking.
- CNG is compressed so a large volume may be stored in a relatively compact space, such as on-board a vehicle.
- CNG is stored on-board a vehicle at 3,600 psi. CNG does not change state – it remains a lighter-than-air gas.
- CNG fuel storage systems (i.e. cylinders) pass US DOT tests that no gasoline or diesel fuel tanks could ever survive. These tests include dynamite, bonfire, gunfire, drop, and crash tests.
- CNG cylinders can be Type 1 (all metal – typically steel or aluminum), Type 2 (metal liner with fiberglass – hoop wrapped), Type 3 (metal liner with fiberglass – full wrap), and Type 4 (plastic liner with full composite wrap).

So what is CNG? (cont)

- CNG is measured in gasoline gallon equivalents (GGEs) and diesel gallon equivalents (DGEs).
- CNG has an octane rating of 130 versus an octane rating between 87-94 for gasoline.
- All CNG engines, regardless of the size of the vehicle, are gasoline-type spark ignited engines.



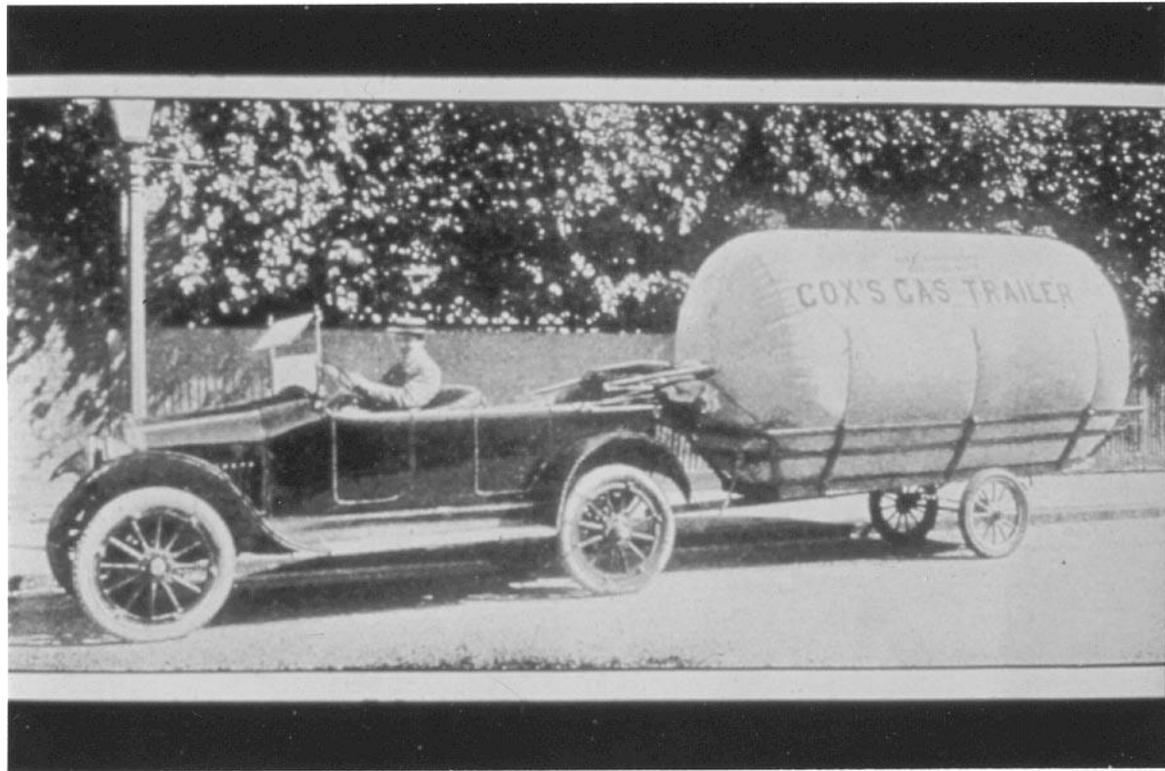
Compressed Natural Gas (CNG) Vehicle Facts:

- On average, CNG vehicles emit (regulated emissions): 95% percent less particulate matter (PM), also known as soot, 90% percent less carbon monoxide (CO), and 75% less nitrogen oxide (NOx).
- On average, CNG vehicles emit (non-regulated emissions): 20-25% less carbon dioxide (CO₂) compared to diesel vehicles and 30-35% less CO₂ compared to gasoline vehicles.
- CNG vehicles (medium- and heavy-duty) are extremely quiet compared to their diesel counterparts.
- According to Cummins-Westport, one (1) diesel engine idling alone is louder than ten (10) CNG engines idling together.
- CNG is the most prevalent alternative fuel in use today in New England.

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Natural gas is one of the six (6) federally-recognized alternative fuels:

- Bio-diesel (B-20)
- Electricity (EVs)
- Ethanol (E-85)
- Hydrogen (compressed - CHG and liquefied - LHG)
- Liquefied petroleum gas (LPG) - commonly known as propane
- Natural gas (compressed - CNG and liquefied - LNG)

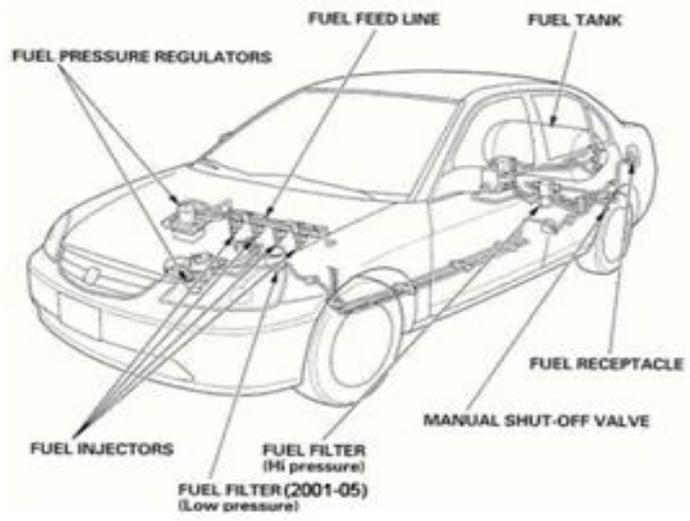




HONDA
Automobile Technical Training

GXC02 - Civic GX Fuel System Components

GX Fuel System Components



On-road applications for CNG (in order of economic feasibility):

- Refuse/recycling - trash removal and recycling collection
- Transportation - transit buses (RTAs), airport / hotel shuttles / transportation companies
- Delivery - beverage, linen, dry goods, and package
- Freight - intrastate and interstate
- Utilities - customer service vans, distribution trucks, pool sedans, line trucks
- Municipalities - DPWs, schools, senior transportation
- Consumers and first adopters



On-road vehicle offerings:

- Dedicated CNG: CNG is the only fuel on-board the vehicle.
- Bi-fuel: CNG and gasoline. Two (2) independent fuel systems on-board. The vehicle typically operates on CNG. As the CNG supply is depleted (according to pressure), the vehicle automatically changes over to gasoline. Only one fuel is consumed at a time.
- Dual-fuel: CNG and diesel. CNG and diesel are burned simultaneously in the engine (in varying percentages). CNG displaces approximately 70% to 80% of the diesel normally consumed.
- At this point in the industry's history, nearly every major automobile, bus, and truck manufacturer offers some type of CNG option.
- The best resource is: www.ngvamerica.org
Go to "Technology"
Then to: "Available Vehicles and Engines"

CNG Station Facts:

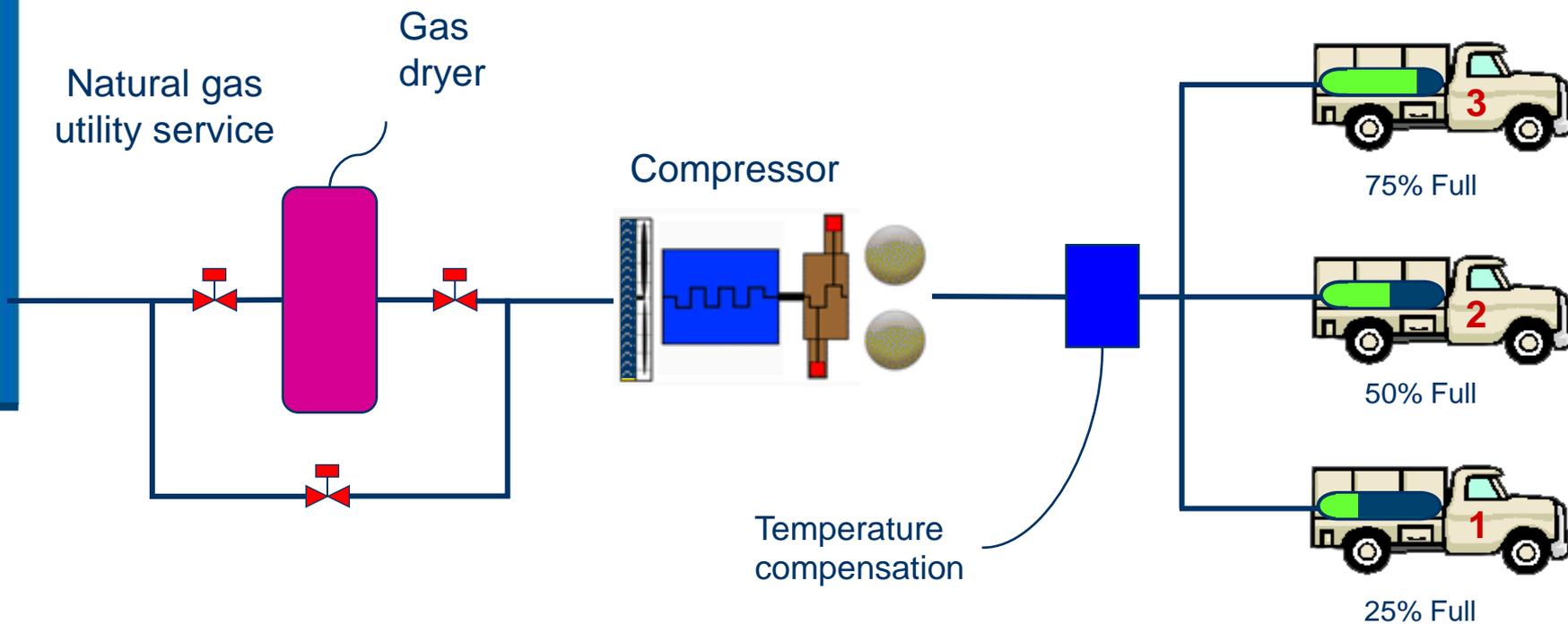
- CNG stations require no fuel deliveries. Natural gas is delivered to the station directly from the existing underground natural gas infrastructure.
- CNG storage is above ground (at 4,500 psi). A typical fast-fill station stores an amount of fuel approximately equal to 300 gallons of diesel fuel.
- If there were to be a leak (which is very unusual), the CNG would readily dissipate into the atmosphere.
- CNG station site selection includes: finding highest natural gas pressure as possible, 460 VAC - 3 phase electric power supply, and for public-access station - proximity to fleet customers.
- Space requirements: Approximately 15,000 to 20,000 square feet for a full public-access CNG station.

Compressed Natural Gas (CNG) Station Facts (cont.):

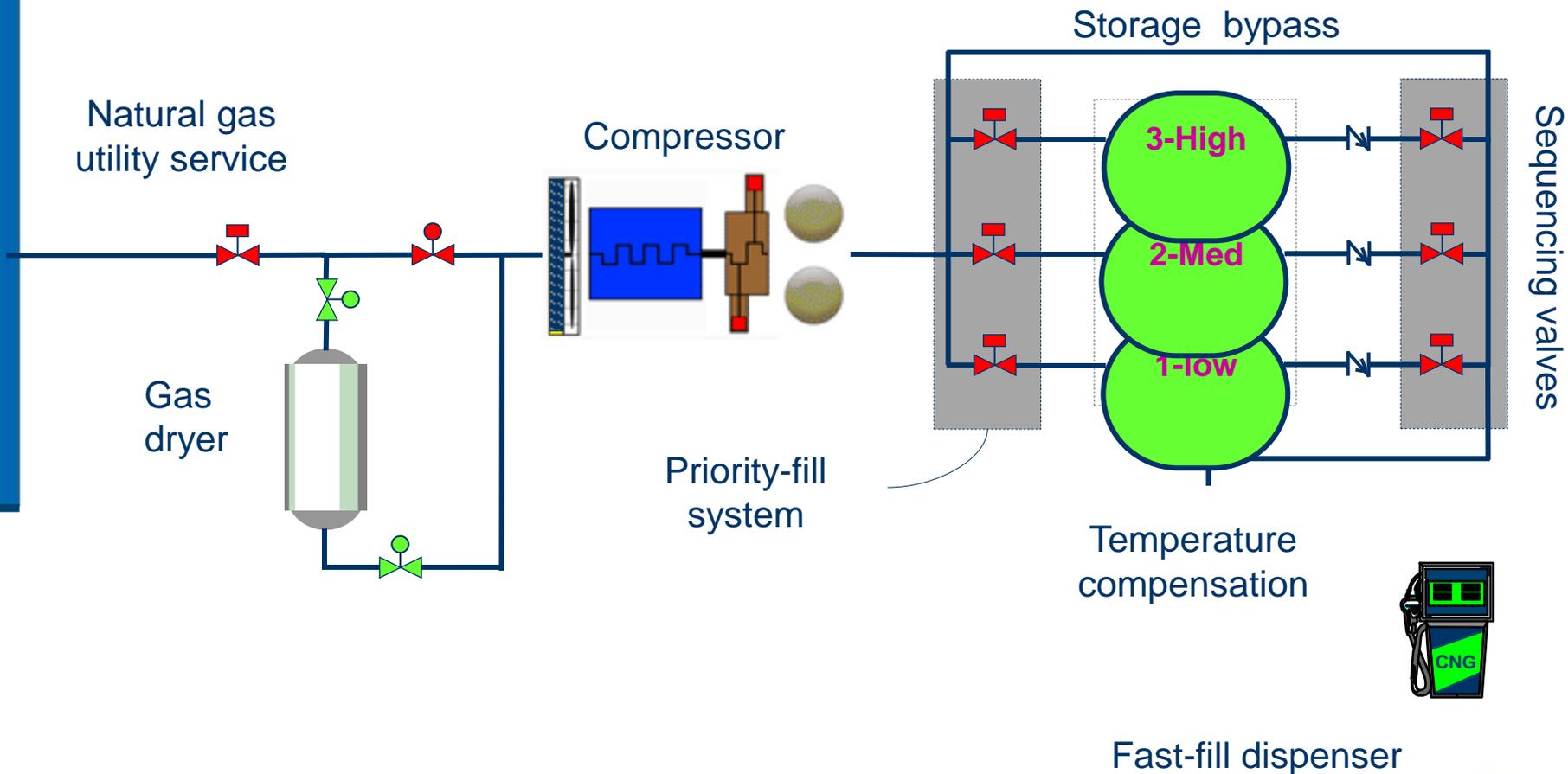
- CNG stations can be time-fill, fast-fill, or combination time- and fast-fill.
- Each station design has its positives and negatives.



Time-fill Fueling Station



Cascade Fast-Fill Fueling Station



CNG Station Facts (cont.):

- CNG stations can be public-access or private-access
- Public-access CNG stations are typically open 24/7/365
- Public-access CNG stations typically accept Wright Express (WEX), PHH, MasterCard, VISA, and proprietary fuel cards.
- Public-access (retail) CNG stations dispense fuel at:
 - Gasoline gallon equivalent (GGE) = \$2.599
 - Diesel gallon equivalent (DGE) = \$2.849
- Private-access (not open for retail) CNG stations dispense fuel at:
 - Gasoline gallon equivalent (GGE) = \$2.20
 - Diesel gallon equivalent (DGE) = \$2.50

CNG / GH₂ Repair Garages – NFPA 30A

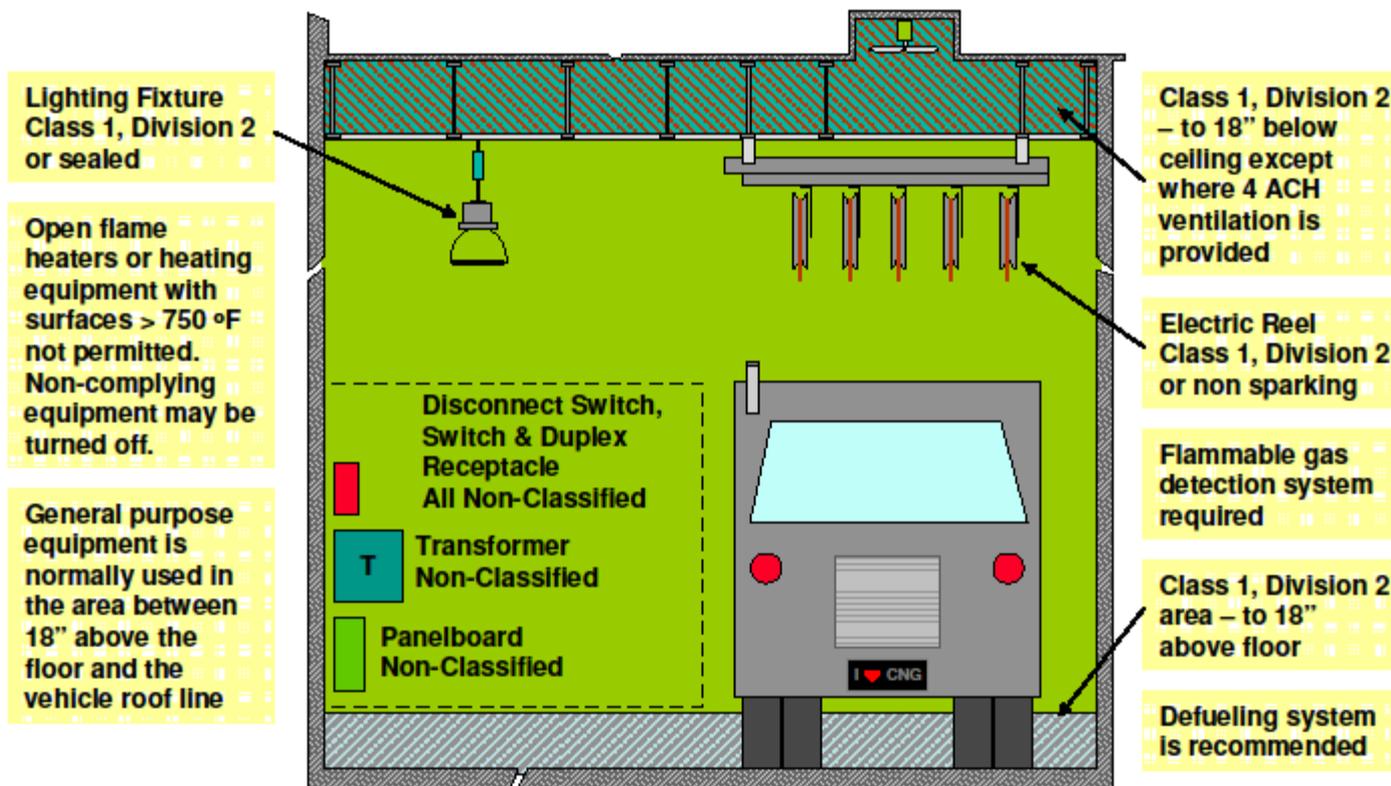


Image Credit: U.S. DOE, Alternative Fuels & Advanced Vehicles Data Center, CNG 201

If you have any questions, please feel free to contact me at:

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