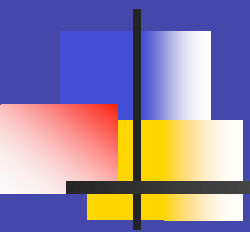


Southern California AFV Expo Natural Gas Infrastructure Partnering Workshop



NGV Infrastructure Panel
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Subjects Presented

- Natural Gas Supply Options
- How Natural Gas Fueling Works
- Fueling Station Types
- Fueling Station Equipment – What it Does
- Fueling Issues
- Fueling Station Training Needs and Options

Natural Gas Supply Options (To The Fueling Station)

- Option 1: Natural Gas Supplied From a Utility Distribution Pipeline
 - Typical Supply to a Conventional Compressed Natural Gas (CNG) Fueling Station
- Option 2: Natural Gas Supplied from a Delivery Truck
 - May be Delivered as Liquefied Natural Gas (LNG) or CNG

How Natural Gas Fueling Works

- Compressed Natural Gas (CNG)
 - Pressure transfer to vehicle
- Liquefied Natural Gas (LNG)
 - Liquid transfer to vehicle
- LNG to CNG
 - Liquid to gas conversion and pressure transfer to vehicle (LCNG)

Fueling Equipment (CNG)

- Remove water and other material from gas
- Compress gas
- Direct compressed gas to storage system
- Provide onsite storage of compressed fuel
- Direct gas from storage to vehicle
- Temperature compensation system
- Measure and dispense fuel
- Emergency Shutdown System

Fueling Equipment (CNG)

- Gas Dryer - removes water
- Compressor(s)-increases gas pressure
- Priority System – directs gas to storage
- Gas Storage - stores compressed gas
- Sequential System – directs gas to vehicle
- Temperature Compensation – provides full-fill
- Dispenser(s) - meters and dispenses fuel
- Emergency Shutdown System (ESS) – stops the flow of fuel

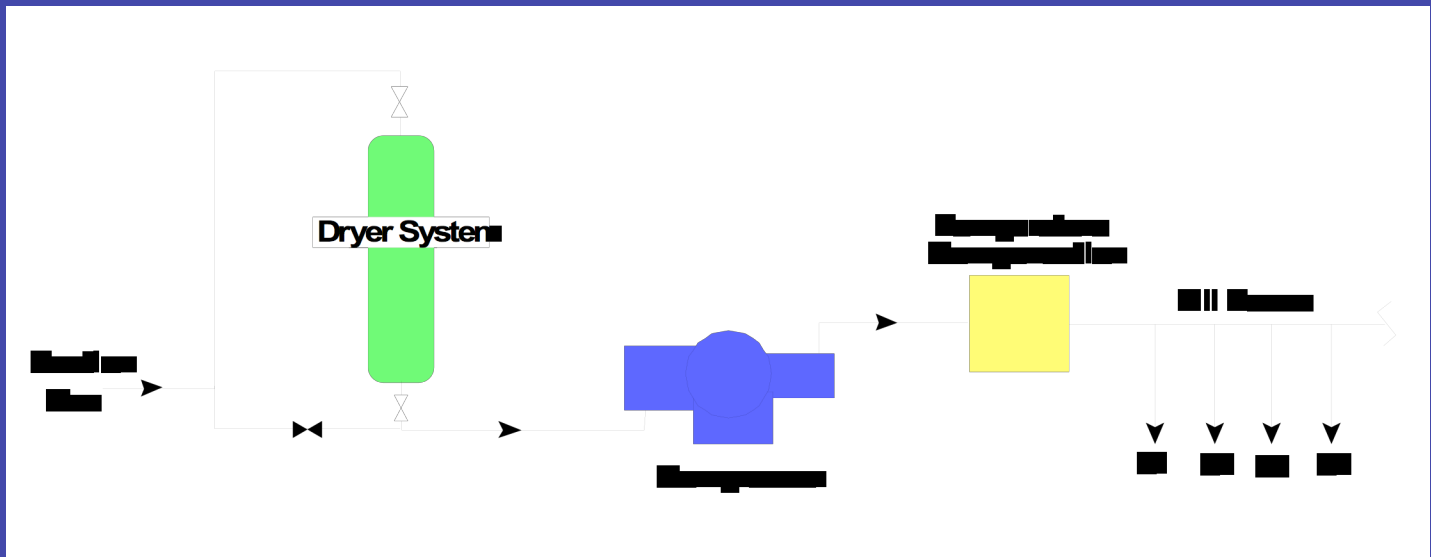
Fueling Station Types (CNG)

- Time-Fill
- Cascade Fast-Fill
- Buffer Fast-Fill

Fueling Equipment Time-Fill

- Gas Dryer - removes water
- Compressor(s)-increases gas pressure
- Temperature Compensation – provides full-fill
- Dispenser(s) - dispenses fuel
- ESS-stops the flow of fuel

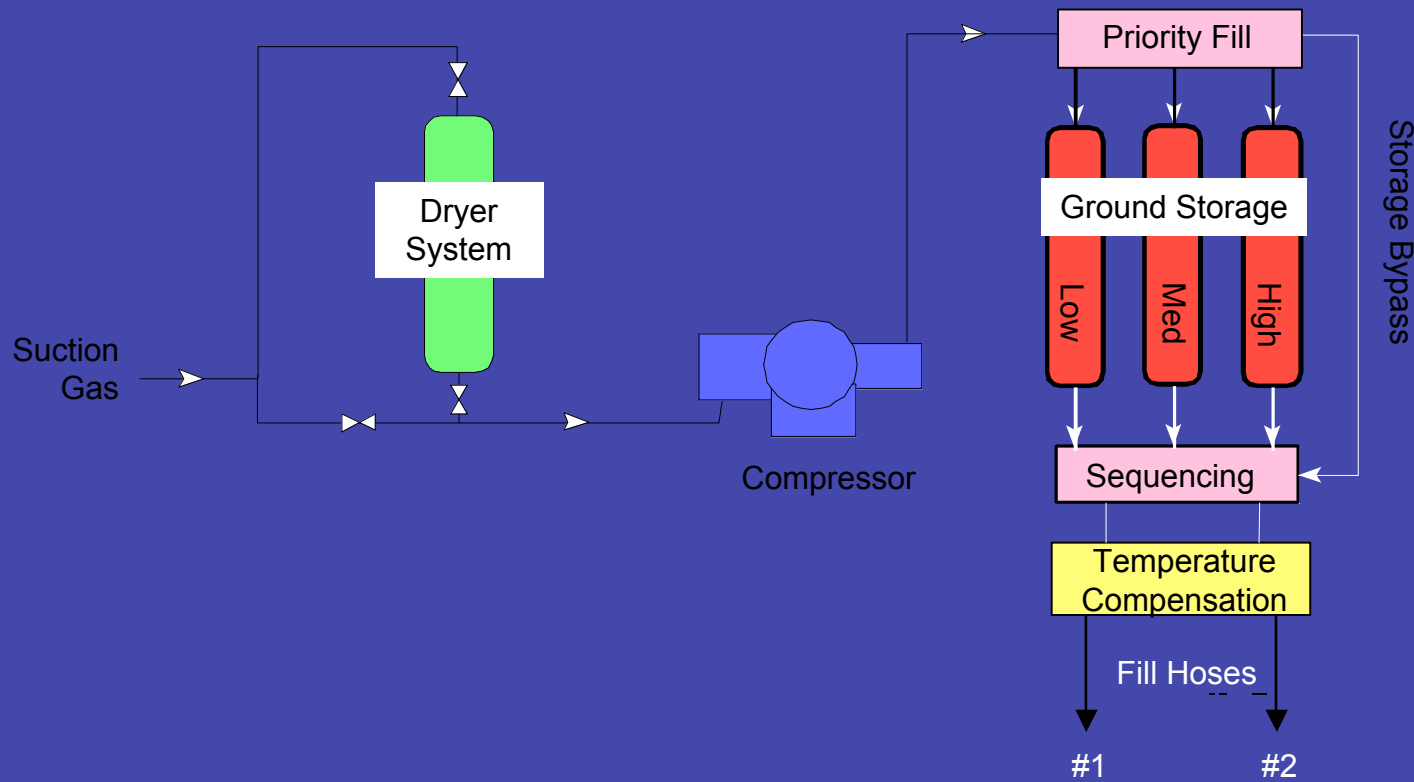
Time-Fill Fueling System



Fueling Equipment Cascade Fast-Fill

- Gas Dryer - removes water
- Compressor(s)-increases gas pressure
- Priority System – directs gas to storage
- Gas Storage System – stores high pressure gas
- Sequential System – directs gas to vehicle from storage
- Temperature Compensation – provides full-fill
- Dispenser(s) - dispenses fuel
- ESS – stops the flow of fuel

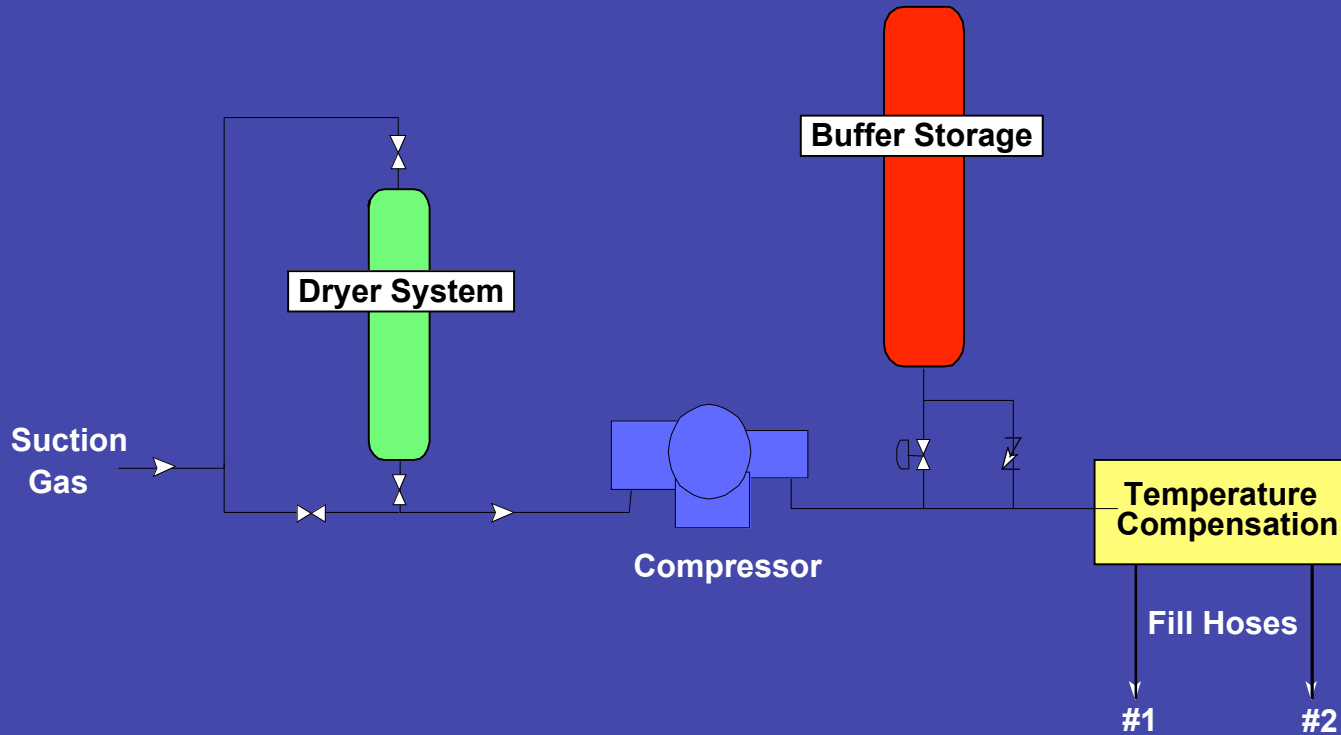
Cascade Fast-Fill Fueling System



Fueling Equipment Buffer Fast-Fill

- Gas Dryer - removes water
- Compressor(s)-increases gas pressure
- High Pressure Gas Storage – stores gas between filling events
- Temperature Compensation – provides full-fill
- Dispenser(s) - dispenses fuel
- ESS – stops the flow of fuel

Buffer Fast-Fill Fueling System



Fueling Equipment (LNG)

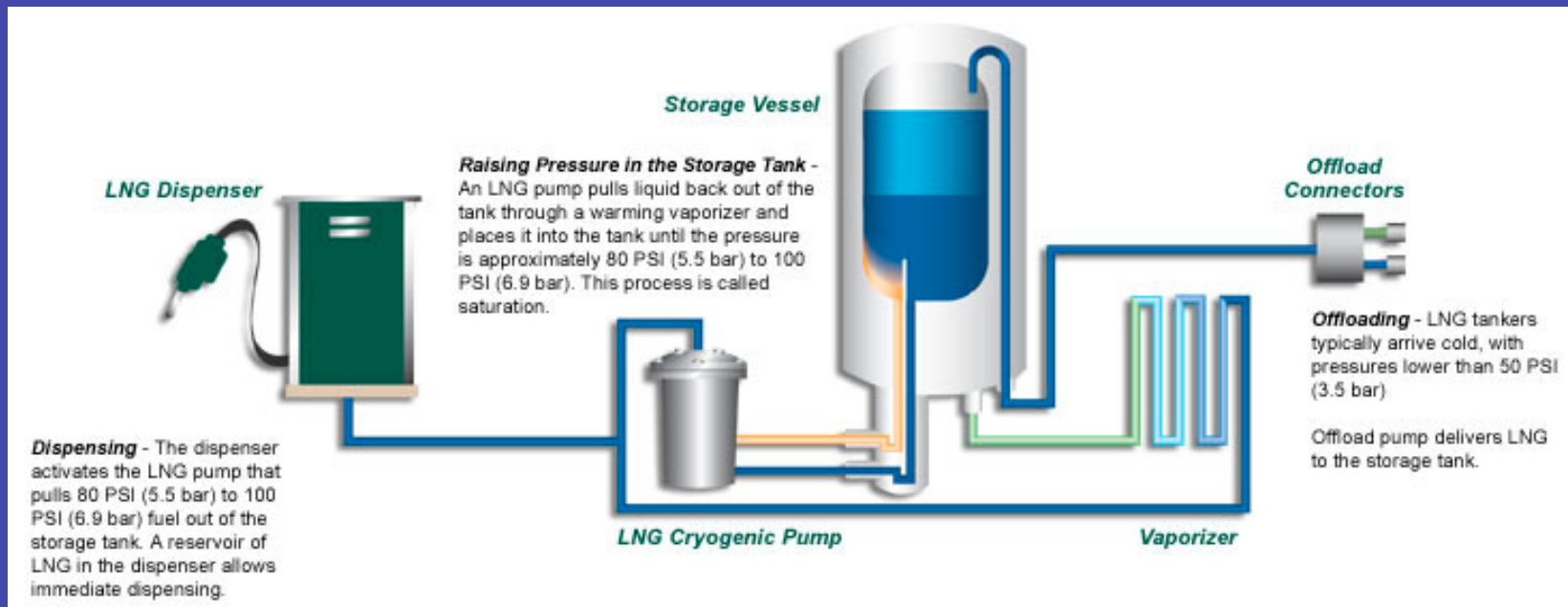
- Tank Truck Off-Loading System
- Cryogenic Liquid Storage Tank
- Cryogenic Liquid Pump
- Measure and Dispense Fuel
- Emergency Shutdown System (ESS)



LNG Fueling Equipment

- Offloading System - offload liquid fuel
- Cryogenic Liquid Storage Tank – stores liquid fuel
- Cryogenic Liquid Pump – pumps liquid from storage to dispenser
- Dispenser(s) - meters and dispenses fuel
- ESS – stops the flow of fuel

LNG Fueling



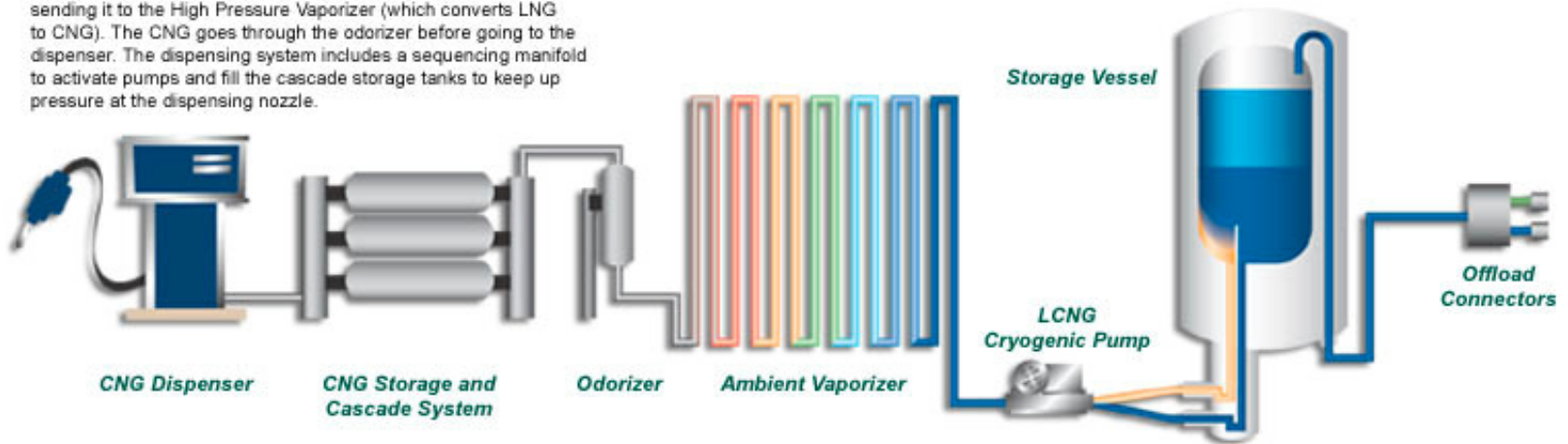


LCNG Fueling Equipment

- Offloading System - offload liquid fuel
- Cryogenic Liquid Storage Tank – stores liquid fuel
- Cryogenic Liquid Pump – pumps liquid from storage to dispenser
- Heat Exchanger – Liquid becomes a high pressure gas
- High Pressure Storage – stores high pressure gas
- Odorizer – odorize high pressure gas
- Dispenser(s) - Measure and dispense CNG fuel
- ESS – stops the flow of fuel

LCNG Fueling

Dispensing - The dispenser pulls initially from CNG stored in the cascade storage tanks, then activates the LCNG pumps. Those pumps raise the LNG pressure to 4,500 PSI (310.3 bar) before sending it to the High Pressure Vaporizer (which converts LNG to CNG). The CNG goes through the odorizer before going to the dispenser. The dispensing system includes a sequencing manifold to activate pumps and fill the cascade storage tanks to keep up pressure at the dispensing nozzle.



Sizing Natural Gas

Fueling Equipment (CNG)

- Number of vehicles
- Quantity of fuel per vehicle
- Total quantity of fuel in 30 minute peak period
- How many 30 minute peak fueling events in 24 hours

(Fuel compressed and stored on site)

Sizing Natural Gas

Fueling Equipment (LNG)

- Number of vehicles
- Quantity of fuel per vehicle
- Total quantity of fuel per day
- How many days before fuel needs to be delivered

(Liquid Fuel delivered by truck and stored on site)

Sizing Natural Gas

Fueling Equipment (LCNG)

- Number of vehicles
- Quantity of fuel per vehicle
- Total quantity of fuel in 30 minute peak period
- How many 30 minute peak periods in 24 hours

(Liquid Fuel delivered by truck and stored on site)

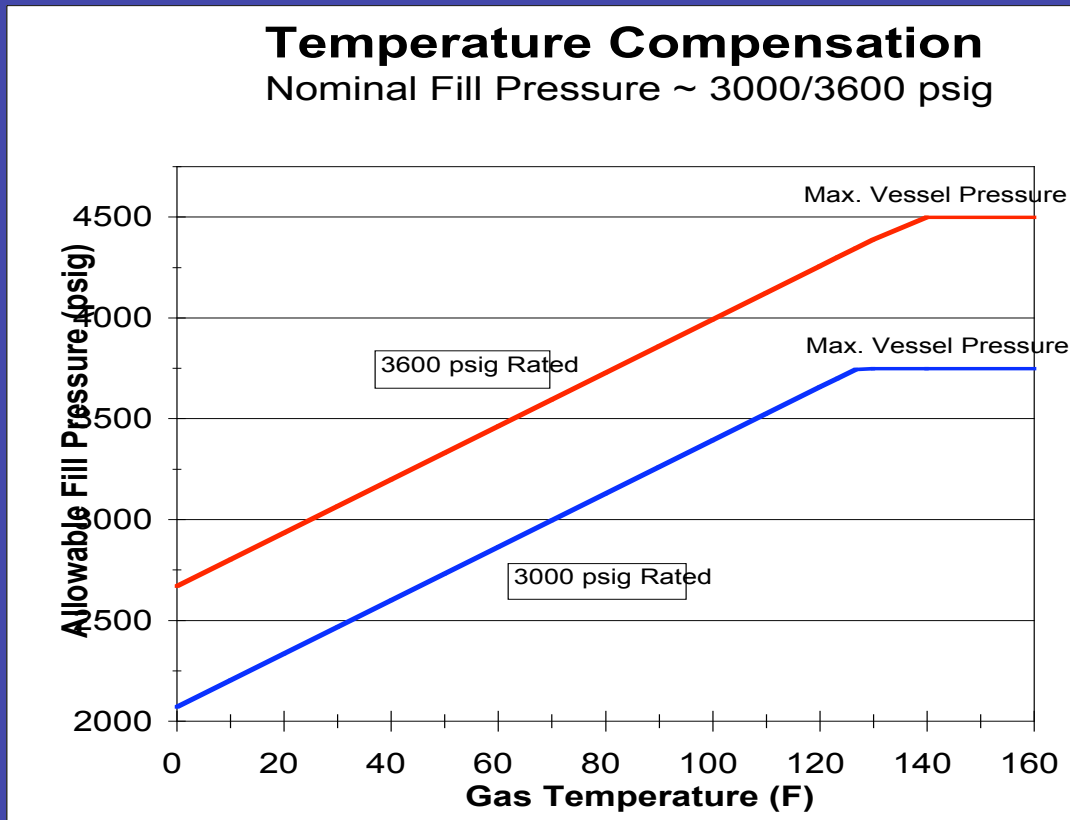


Fuel Quality and Fueling Issues (CNG)

- Gas quality (water, oil, particulate)
- Temperature compensation (ambient & heat of compression)

Temperature Compensation for 3000 & 3600 psig.

Any point on the sloped line represents a constant mass in the vessel. Max vessel pressure must not be exceeded.





Fuel Quality and Fueling Issues (LNG)

- Liquid fuel composition (99.999% Methane)
- “Hot” vehicle tanks (150 – 200 psi)



Fuel Quality and Fueling Issues (LCNG)

- Liquid fuel composition (99.999% Methane)
- Temperature compensation (ambient & heat of compression)

Fueling Station Training Needs

- Fueling station design, procurement, and installation
- Fueling station operation and maintenance
- Driver/fueler safety
- Vehicle mechanic technical and safety
- Vehicle fuel cylinder inspection
- Facility modification

Fueling Station Training Options

- NGV Institute
 - CNG fueling station design, procurement and installation
 - CNG fueling station operation and maintenance
 - Driver/fueler safety
 - Vehicle mechanic safety
 - Vehicle fuel cylinder inspection
 - Facility modification

Fueling Station Training Options

- National Alternative Fuels Training Consortium – College of the Desert
 - Vehicle technician
 - Vehicle fuel cylinder inspection
- Rio Hondo Community College
 - Vehicle technician