



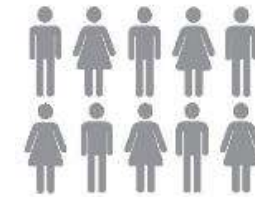
Alternative Fuels and Repair Facilities

Introduction: Gas Technology Institute

Independent, not-for-profit established to tackle tough energy challenges, turning raw technology into practical solutions.



- Idea
- Market Analysis
- Technology Analysis
- Product Development
- Lab and Field Testing
- Demonstration
- Commercialization



RESEARCH & DEVELOPMENT



PROGRAM MANAGEMENT



TECHNICAL/ ANALYTICAL



CONSULTING



TRAINING

Introduction:



Clean Energy Fuels Corp. is the leading provider of natural gas fuel for transportation in North America.

- Clean Energy builds and operates CNG and LNG vehicle fueling stations, manufactures CNG and LNG equipment and technologies, and delivers more CNG and LNG vehicle fuel than any other company in the U.S.
- The Facility Modification Services Division within CE was formed in 2012, and has completed over 2,000,000 of garage space!
- www.CleanEnergyFuels.com.

Introduction: Dept. of Energy's Clean Cities

- GTI and Clean Energy are supported in this effort by a competitively awarded, cost-shared agreement from the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy (EERE), under Award Number DE-EE0007815.

Current Status - Natural Gas in Transportation

Significant market share in refuse and transit

- 60% and 35%, respectively

Gaining in regional haul

- (~1% to ~2%) with industry goal of 10% of this 200,000+ per year market
- Cummins-Westport engines lead the way with 80,000 total (~7,000 to ~10,000 per year)
- Mostly 9L followed by 12L and then 6.7L
- All meet optional “near-zero” standards

High fuel use drives adoption



B6.7N™



L9N™



ISX12N™

Future of Natural Gas in Transportation

Environmental Push

- Greenhouse Gas Regulations – EPA Phase 2 2027
- Renewable Natural Gas (RNG) – lowest Carbon Intensity (CI) value
- NOx – 4 in 10 Americans breathe unhealthy air
- Research & Development funding strong (DOE/CARB/CEC)

Market Pull

- RNG – credits lead to off-loading needs
- Mobile Pipeline and Off-road (led by marine)
- If diesel prices go up again...

Early-stage, potential markets

- Light-duty “work trucks”
- EVs and Hydrogen (distributed generation)



Safety in Repair Facilities

Properties

- Methane (CH₄) is the main component of natural gas, both the compressed and liquefied versions, CNG and LNG.
- Propane is less common as a vehicle fuel, but does exist.
- Both are flammable, but only within a narrow concentration range of air to natural gas mixtures.
- Natural gas is lighter than air, and will rise to the top of a structure.
- Propane and LNG will fall to the floor initially, but easily disperse.

Methane Properties

Compound	Formula	Density (lb/ft ³) Gases @ STP	Auto-Ignition Temperature (°F)	Lower Flammability Limit (LFL) %	Upper Flammability Limit (UFL) %
CNG (Methane)	CH₄ (majority)	0.045	1,004	5.3	15.0
Propane	C ₃ H ₈	0.12	850-950	2.2	9.5
Gasoline	C ₈ H ₁₈	0.29	495	1.4	7.6
Diesel	-	>0.38	600	1.0	6.0
Hydrogen	H ₂	0.0056	1,050-1,080	4.1	74.00
Air	-	0.0806	-	-	-

Key Concepts

- **Detect** – Install a properly designed / functioning methane detection system.
- **Dilute** – Provide a means for fresh air to enter the facility.
- **Extract** – Explosion-proof ventilation on stand-by in case of a leak



Gas Detection

Gas Detection Systems

- The primary functions of a combustible gas detection and alarm system are to:
 - Provide warning to occupants that a methane gas release has occurred.
 - Initiate actions to eliminate potential ignition sources.
 - Initiate actions to dilute and extract mixtures of natural gas.
- Gas detection systems are not required by code but are often used to minimize operating costs.

Gas Detection Systems

- Generally, combustible gas detectors:
 - Should be near the highest point of the structure's ceiling.
 - May be at intermediate locations to “intercept” the likely path that a vapor release would take as it rises to the high point.
- The number, location, and spacing of detectors must be determined by a licensed design engineer and approved by local inspectors.



Alarms

- A detection level of 25% of the LFL should be used to initiate alarms and other actions.
- The use of two gas detection levels rather than a single value has gained wide acceptance, but still needs AHJ approval.





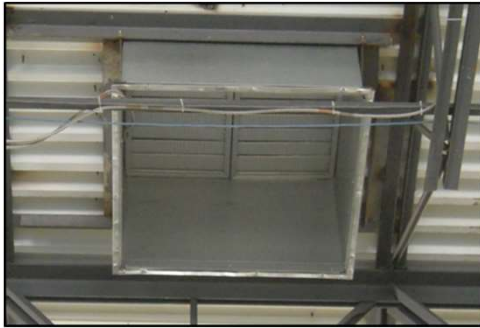
Dilute & Extract

Ventilation Requirements

- Ventilation the primary strategy to prevent natural gas accumulations at concentrations within the combustible range.
- Most garages use one of three options for controlling ventilation:
 1. Continuously
 2. Upon demand for ventilation triggered by the methane detection system
 3. For CNG only, continuously while the space is occupied, via interconnection with the lighting circuit

Ventilation Strategies

- Safety codes do not specifically address how the ventilation is to be achieved.
- The most common form of facility ventilation is roof-mounted up-blast fans that exhaust to the atmosphere in a safe area. These exhaust fans can pull air directly from the space via the fan inlets or through ductwork.





Sources of Ignition

Space Heating

- Open flame heaters or heating equipment with exposed surfaces having a temperature in excess of 750 °F should be removed from areas subject to ignitable concentrations of gas.
- Low-lying heaters are an issue in LNG and propane facilities.



Electrical Equipment

Wiring, lighting, and electrical appliances are all potential ignition sources.

- In repair garages, the area within 18 inches of the ceiling is considered a Class I, Division 2 hazardous location.
- For LNG and Propane, the floor area and pits are also a concern.
- Properly designed ventilation can circumvent this requirement.
- Examples of equipment that might be an ignition risk
 - Fans
 - Lights
 - Conduit
 - Garage door motors
 - Cranes



Review

- **Detect** - Gas detection systems that alarm at 20% and 40% of LEL
- **Dilute** - Bring in fresh makeup air from near the floor.
- **Extract** - Intermittent, Continuous, or Natural ventilation
- **Eliminate Ignition Sources** - Place electrical and heating devices away from potential gas collection zones or install electrically classified equipment.



For More Info: AltFuelGarage.org



Appendix

ILITY MODIFICATION- STRATEGY

Facility Assessment / Gap Analysis

- Classified Zones
- Appliances
- Roof and Wall Construction
- Mechanical Exhaust and Supply for Ventilation
- Electrical System Capacity
- Conceptual Plan
- Cost Estimate
- Alternatives

Engineering Design

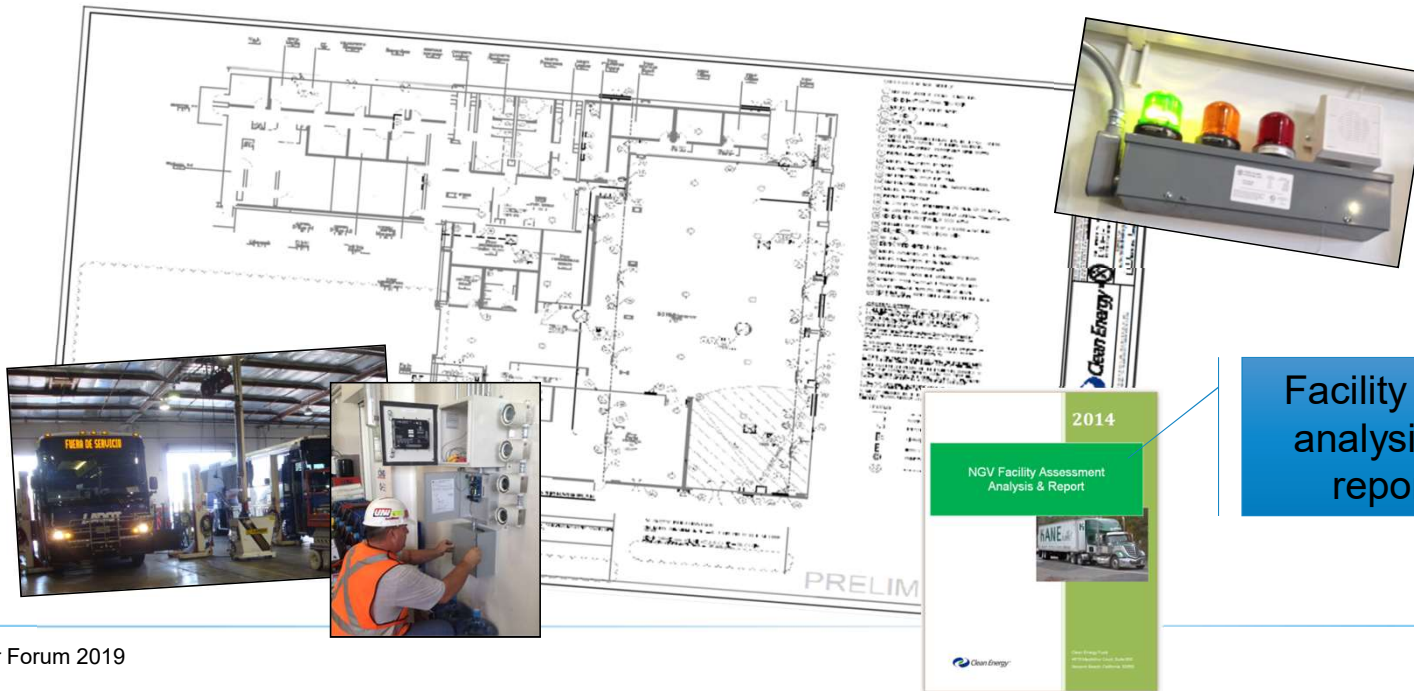
- Develop Detailed Construction Documents
- Complete Permitting through Local Jurisdiction
- Fire Plan

Construction

- Construction Administration
- Experienced Supervisors and Craftsmen
- Qualified contractors
- Industrial Equipment
- Startup, Testing & Training

FACILITY MODIFICATIONS - OPTIONS

Full or partial shop modifications



Facility gap analysis & report

FIT SERVICE PROGRAM

The successful function of a gas detection and mitigation system hinges on a properly executed service plan.

Program Details:

- Trained OEM certified technicians.
- Bi-annual testing (recommended), inspections, and light maintenance is performed on mechanical and electrical system components.
- System health is evaluated and potential trouble points identified, including recommended remediation measures provided.
- A report is generated for the client.
- Record keeping, data logging, and on-going support, available.



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