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Safe Transportation of Liquefied Natural Gas by Railroad Tank Car – Phase II: Public Meeting 3

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- 2002 - Founded Gas Innovations as wholesale supplier of high pressure and specialty gases
  - Specialize in sourcing, procurement, purifications, packaging, and distribution
  - Original key product lines included:
    - Propylene
    - Hydrogen Chloride
    - Service and maintenance
- 2004 - Founded Southern Propane as subsidiary of Gas Innovations
  - Invested in LPG transports ~8,700 gals each and bobtail transports ~4,000 gals each
  - Constructed bulk storage at LaPorte Facility
- 2005 – Continued growth as a wholesale supplier of high purity hydrocarbons
    - High purity hydrocarbons (propane, n-butane, i-butane, i-pentane, etc.)
    - Began moving rail cars of propylene, ~5 per month
      - Propylene distribution network includes Gulf Coast and Midwest
- 2015 - First entry into LNG supply chain as supplier of hydrocarbon refrigerants for start up of LNG Project in Australia
    - Supplied 84 high pressure tube modules for start up of liquefaction process
    - Repurposed high pressure tube modules to provide high purity specialty gases and hydrocarbons to U.S. customers
      - Methane, Hydrogen, Ethylene, Ethane, Carbon Monoxide
- 2017 – Invested in assets and infrastructure to become leading supplier of hydrocarbon refrigerants to the LNG industry
  - First supplier to distribute cryogenic ethane by transport in U.S.
  - Purchased fleet of MC338 Cryogenic Transports to supply and distribute cryogenic ethane and ethylene to U.S. customers
  - Purchased fleet of MC331 LPG Transports to supply and distribute high purity Propane, n-Butane, I-pentane to U.S. customers
  - Built out cryogenic storage (LNG, Ethane, & Ethylene) in LaPorte, TX

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- **Liquefied Petroleum Gas**
  - Current consumption of LPG products at trans-fill rail locations in Texas, Louisiana, and Pennsylvania
    - 5-7 rail cars per month propylene
    - 10-15 rail cars per month propane
    - 3-4 rail cars per month n-butane
- **Cryogenic Hydrocarbons**
  - Supply 20-30 cryogenic ethylene bulk transport loads (~8,700 gallons each) to customers per month
    - Equivalent volume to 10-15 rail cars
    - Typical distribution route ~250 miles one way trip
    - Some East Coast customers ~1,000 one way trip
  - Fill and export 3-4 cryogenic ISO containers of Ethane per month
    - Equivalent volume to 1-2 rail cars
    - Have completed campaigns of 10 per month
    - 1,500 miles from cryogenic ethane origination to Laporte, TX

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- **Experience with Cryogenic Hydrocarbons**
  - LNG distributed in smaller quantities in bulk (~9,000 gallons each)
    - Rail transportation would provide more efficient/environmentally sensitive transportation option to move to rail hubs/spurs and transfill for distribution via cryogenic transport trailers
    - Cryogenic methane (LNG) most cost efficient distribution method for high purity methane
      - LNG vaporized is treated/purified and compressed into high purity methane in high pressure tube trailers
      - Various applications include cracker start ups, electronics, engine testing
  - Cryogenic ethane not approved for rail transportation under current regulations
    - Gas Innovations has submitted special permit application to transport cryogenic ethane in rail car with reasoning that ethane is as safe or safer than ethylene and should be permitted.
    - Ethane is a non-VOC (Ethylene is a VOC)
      - To date, most US ethane has been put back into pipeline under BTU thresholds or used in production of ethylene

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	Ethylene	Ethane	Liquefied Natural Gas
Approved for rail transportation in cryogenic form?	Yes	No	Yes
Boiling Point	-155 deg F	-128 deg F	-259 deg F
Vapor Pressure in compressed form	1200 psi at 70 deg	544 psi at 70 deg	
Flammability in Air	2.7 – 36%	3.0 – 12.4%	5.0 – 15%
Density at Boiling Point	4.71 lbs per gal.	4.56 lbs per gal.	3.552 lbs per gal.
Specific Volume	13.7 cuft / lb	12.8 cuft / lb	24.1 cuft / lb
Classification	Alkene Double bond	Alkane Single bond >> stability than Ethylene	Alkane Single bond
Specific Gravity in Air (Air = 1)	.9683	1.047	.5537
Expansion Ratio	483 cuft vapor: 1 cuft liquid	437 cuft vapor: 1 cuft liquid	640 cuft vapor: 1 cuft liquid

**Degree of flammability or combustibility in air depends largely upon the volatility of the material

- Dependent on composition-specific vapour pressure at ambient temperature
- When evaluating Hydrocarbon stability, bonding is indicative of relative stability

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	Propane	Butane	Liquefied Natural Gas
Approved for rail transportation?	Yes Compressed Gas	Yes Compressed Gas	Yes Cryogenic Gas
Vapor Pressure	110 psi at 70 deg F	16 psi at 70 deg F	
Flammability in Air	2.2 – 9.5%	1.8 – 8.4%	5.0 – 15%
Specific Volume	8.5 cuft / lb	6.4 cuft / lb	24.1 cuft / lb
Classification	Alkane Single bond	Alkane Single bond	Alkane Single bond
Flammability in Air	2.7 – 36%	3.0 – 12.4%	5.0 – 15%
Specific Gravity in Air (Air = 1)	1.52	2.07	.5537
Expansion Ratio	269 cuft vapor: 1 cuft liquid	232 cuft vapor: 1 cuft liquid	640 cuft vapor: 1 cuft liquid

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- **Comparing LNG vs. other hydrocarbons**
  - VOC status
    - Ethane and Methane are non-VOC
    - Ethylene is a volatile organic compound
      - *Volatile organic compounds, or VOCs are organic chemical compounds whose composition makes it possible for them to evaporate under normal indoor atmospheric conditions of temperature and pressure*[3]
  - LNG more stable and less flammable in air than Cryogenic Ethylene
    - Ethane more stable and less flammable in air than Ethylene
  - Flammability
    - Methane flammability 5.0 – 15%
    - Crude Oil for example: 0.8% - 8.0%
  - Methane is lighter than other LPG products shipped in rail
    - Propane and Butane shipped in compressed form
    - Higher specific gravity in air means potential for accumulation in low lying areas “pooling” compared to methane which is much lighter and would diffuse/evaporate

	Propane	Butane	Liquefied Natural Gas
Specific Gravity in Air (Air = 1)	1.52	2.07	.5537