

## Impact of H<sub>2</sub> Enriched Natural Gas (HENG) on Feedstock for Liquefied Natural Gas Liquefaction

**Description:** Define and evaluate the impacts of HENG on plant materials and plant operations, and determine potential feedstock pretreatment or hydrogen rejection options.

**Status:** Thermodynamic analysis of the LNG Plant and materials of construction analysis are complete.

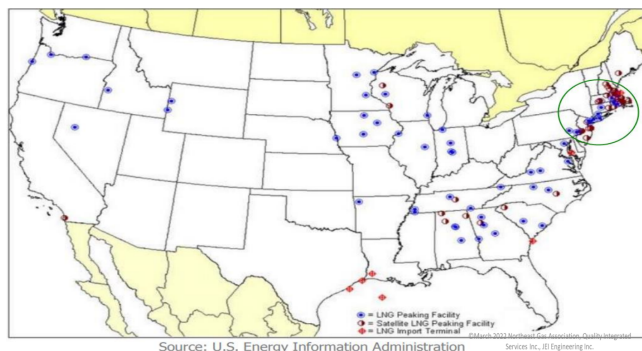
### BENEFITS

This project provides Liquefied Natural Gas (LNG) plant operators and decision-makers the ability to ascertain what the best procedures and pretreatment / retrofit options could be. It also provides a technical basis for pursuing rate-recovery for necessary retrofits to meet future feedstock requirements. Also, this project provides operators with access to specific mitigation options that could be applied to their LNG facility.

### BACKGROUND

There are a number of Liquefied Natural Gas (LNG) Plants connected to natural gas (NG) systems in the United States. Several are in the Northeast, particularly Massachusetts, Connecticut, and Rhode Island as well as New Jersey, New York, and Pennsylvania. There are also plants in the Mid-Atlantic states, in the South, and in California. Gas customers in some of these regions, at critical times, rely on peak-shaving LNG to meet their natural gas needs. As decarbonization becomes more prevalent and natural gas systems are converted to lower carbon fuels, the use of blended hydrogen (H<sub>2</sub>) up to 20% blends or pure H<sub>2</sub>, will become more prevalent. With that in mind, the natural gas industry and its R & D organizations are exploring a range of issues related to LDC infrastructure, appliances, materials compatibility, etc. To date, there has not been a focus on the impact of H<sub>2</sub> on LNG Liquefaction and corresponding mitigation options.

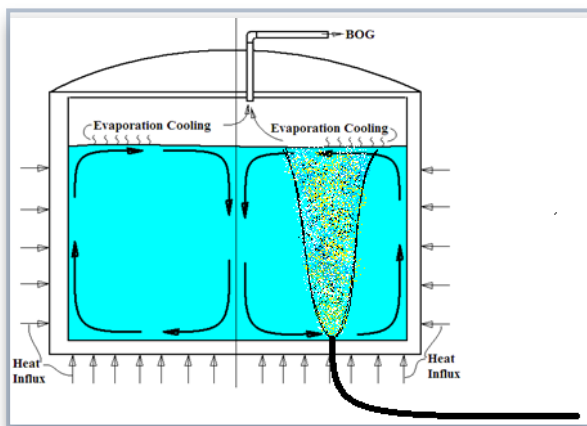
In November 2021, the Northeast Gas Association (NGA) conducted an H<sub>2</sub>-Enriched NG Technical Workshop for its members and members of the American Gas Association (AGA) LNG Committee to explore LNG peak-shaving plant operations.



**Figure 1: LNG Plant Locations in the US**

Those companies, some of which are members of NYSEARCH, strongly endorsed the idea that the industry needs to consider several challenges and mitigation measures should natural gas pipeline system liquefaction include H<sub>2</sub> at even low concentrations such as 1% by volume. Thus, the basis for a multi-phased research program was formed.

Some of the technical hurdles and likely potential challenges identified for using blended H<sub>2</sub> for LNG Liquefaction include: 1) H<sub>2</sub>, as a gas, can compromise the liquefaction process, 2) the Boil-Off-Gas (BOG) management process that is inherent in tank storage systems could be compromised by concentrations of H<sub>2</sub> and compressibility of BOG becomes an issue, and, 3) storage vessels, gaskets, and gas piping could be affected through H<sub>2</sub> embrittlement. Thus, the idea of liquefying blends of HENG is a challenge. Procedures and feedstock pretreatment equipment may need to be changed to isolate the H<sub>2</sub>. Thus, this project considered the challenges as well as feedstock pretreatment options.



**Figure 2: Bottom fill of LNG tank**

## TECHNICAL APPROACH

The objectives of this project include: 1) defining and evaluating the impacts of HENG on plant materials and plant operations, and 2) determining potential feedstock pretreatment or hydrogen rejection options.

At the outset, NYSEARCH, with project partner Quality Integrated Services (QIS), collected data from the NGA and NYSEARCH funders' facilities and developed an inventory of materials that would be exposed to HENG. Through the use of questionnaires, QIS tabulated, evaluated, and reported the results.

Next, a detailed thermodynamic study was conducted to evaluate every component and process from the inlet valve to the tail gas outlet valve of the identified LNG plant(s). Four (4) plants were evaluated from member facilities for further study. The four (4) identified member facilities range from vintage LNG plants to new construction. It is important to note that the vintage facilities being analyzed meant that they were placed in service in the 1960s and 1970s. Since commissioning at that time, some of the plant data is likely to have changed as equipment was updated and maintenance was performed. Data collection at these vintage facilities is necessary to reflect any changes and ensure thorough analyses. QIS is utilizing two (2) selected codes, ASME B31.3, and ASME B31.12, as reference documents for evaluating the plants. In addition, computations are being

performed to determine the potential quantity of H<sub>2</sub> in BOG as well as in LNG.

In this continuing work, NYSEARCH and QIS is ascertaining what additional R & D is necessary by investigating a range of topics including the adequacy of materials, compression of HENG mixtures, maximum acceptable thresholds (if any) of HENG in feedstocks, gas detection and fire protection system issues and spontaneous combustion concerns.

## PROGRAM STATUS

This project is likely the first thorough technical study of specific issues that are identified from actual facility information as it pertains to HENG. The thermodynamic analysis for the LNG plant and the materials of construction analysis are complete. Four (4) selected member plants are being inventoried and evaluated to provide in-depth analyses.

A future phase is planned to focus on how to mitigate the negative effects HENG feed-gas may have on LNG facilities, and a range of pretreatment, recovery, and reinjection options will be investigated. This work will focus ultimately on mitigation measures associated with BOG management as well as previously identified challenges. The work will engage with SMEs in the design and building of LNG plants and in cryogenic process systems.

### Highlights

- Thermodynamic analysis is complete.
- LNG plant 'materials of construction' analysis is complete.
- Four (4) selected LNG plants are being inventoried and evaluated to collect data for further risk analysis.

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