Engineering and Technical Concerns of the New England LDC Group

Algonquin Gas Quality and Interchangeability Filing
Docket RP07-504

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Overview

- The New England LDCs generally support additional imported LNG

- LNG peak shaving plants play a critical supply role in New England providing 28% of design day throughput

- AGT’s proposed gas quality and interchangeability standards introduce safety and reliability concerns that will impact LNG peak shaving plants with liquefaction.

- Certain proposed AGT gas quality specifications are not based on the historical gas quality these critical processes were designed for and have received.

- Gas quality specifications can be designed that balance safety and reliability concerns with the importance of maximizing supply.
Overview

• The LNG liquefaction plants were designed based upon historical gas quality.

• Most imported LNG complying with the proposed standards would be unusable for current LNG liquefaction processes.

• The LNG plants must be refilled prior to the start of every winter heating season to ensure service to LDC firm customers.

• The reliability concerns could be addressed through unplanned, expensive and otherwise unneeded retrofits to the LNG plants.

• Need defined specifications in order to consider engineering alternatives.
Northeast LNG Plants Connected to Natural Gas Pipeline Systems

Plant Type and Safety Jurisdiction

State Jurisdiction
- Peak-Shaving
- Satellite

PHMSA Jurisdiction
- Export
- Import
- Peak-Shaving
- Satellite
Liquefaction

Pipeline Gas In → LNG Liquefaction Process

- Nominal 50 deg F
- Most Heavy Hydrocarbons
- Some Nitrogen

Process Fuel, Tail Gas, or Disposal

- Mostly methane
- Some C2/C3/C4
- Some nitrogen

Nominal minus 260 deg F

LNG Tank

Vaporization

LNG Liquid → Vaporizers (add heat) → Gas out to LDC system & customers

- Stratification
- Weathering
Role of LNG in the Portfolios

• SCG & CNG both own or operate LNG peak shaving plants with liquefaction capability

• CNG Rocky Hill Plant receives all of its gas supply from AGT

• These liquefaction cycles are feedstock sensitive (sensitive to gas components) and designed based on historical gas quality, and have feedstock design specifications similar to other New England LNG plants with liquefaction.

• These plants are essential to serving firm peak day demand, must be refilled and must be available.

![Pie chart showing the role of LNG in the portfolios]

- LNG peaking, 32%
- Pipeline Flowing, 34%
- Off-site underground storage, 33%
- Other Peaking, 1%
Specific Areas of Concern

Relative to the proposed AGT gas quality tariff, these LNG liquefaction cycles and plants are directly impacted by:

- % Ethane (C2) Propane (C3) Butanes (C4) in the feedstock
- % Nitrogen (N2) in the feedstock
% C2/C3/C4 Issue

SCG & CNG’s nominal plant design compared to GTI Table 3 representative streams:

<table>
<thead>
<tr>
<th></th>
<th>% C2</th>
<th>%C3</th>
<th>%C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>2.9</td>
<td>0.48</td>
<td>0.13</td>
</tr>
<tr>
<td>GTI avg*</td>
<td>6.58</td>
<td>1.52</td>
<td>0.61</td>
</tr>
</tbody>
</table>

* avg may understate effect
% C2/C3/C4 Issue

• AGT proposes no tariff limits on C2/C3/C4 ---this means no restrictions can be imposed per Policy Statement.

• As AGT explained in tariff filing, SCG/CNG will receive unblended LNG—blending not an option.

• Liquefying a gas typical of the GTI avg will generate more than 10 times the volume of liquid hydrocarbons (C2/C3/C4) in the coldbox

• SCG/CNG’s plants cannot safely liquefy a gas of the GTI avg. with the existing liquefaction equipment.

• Additional heat to vaporize the increased hydrocarbon liquids also upsets the process thermal balance.

• Even if higher than historical C2/C3/C4 levels can be safely liquefied, closer tank monitoring during filling and storage would be required.
Nitrogen (N2) Issue

• SCG/CNG liquefaction process have been operating at a historical nitrogen level less than 2.0%.

• AGT proposing a 2.5% nitrogen tariff limit.

• Excessive nitrogen in the liquefied LNG can lead to stratification issues in the LNG stored in the tank

• Unstable stratification can lead to dangerous nitrogen induced “roll-over”

• In a “roll-over,” boil-off rates can rapidly increase beyond the tank equipment capability
  – large volumes of gas will be vented
  – may still cause tank over-pressurization and possible tank failure.
Nitrogen (N2) Issue

- Higher levels of nitrogen will require a combination of process retrofit for nitrogen rejection and/or new monitoring equipment for the tank contents.

- AGT gas supply has historically been less than 2% nitrogen, occasional outliers can be accepted per AGT’s proposed waiver.

- 2% nitrogen injection will permit 74% of LNG samples in GTI Report to be accepted—2.5% permits 82%, small difference in supply.

- Conclusion—2% Nitrogen specification will balance safety and reliability concerns with maximizing supply.
C2/C3/C4 MITIGATION

• Could mitigate for higher levels of C2/C3/C4 with coldbox replacement.

• However, coldbox change may also change other process requirements such as refrigeration energy…..these are complex problems.

• Coldbox replacement is approximately $10M

• However, need certainty of C2/C3/C4 limits in order to consider engineering alternatives.
NITROGEN MITIGATION

- Could mitigate for higher levels of nitrogen with additional nitrogen rejection in liquefaction process.
- This is a separate problem and solution from C2/C3/C4 coldbox replacement.
- Additional nitrogen rejection added to the process also affects process energy requirements.
- Nitrogen rejection estimated cost approx $5M.
- Small amounts of additional nitrogen rejection may be able to be designed into and as part of a coldbox replacement if that is required.
MITIGATION- TANK MONITORING/SAFETY

• Both higher amounts of C2/C3/C4 and/or nitrogen require modifications to current tank filling procedures and closer tank monitoring.

• Closer tank monitoring required to insure product weathering or higher nitrogen content during filling do not cause stratification, and roll-over.

• Additional equipment would be required to monitor density and temperature at different tank levels.

• Adding mixing capability to the tank to prevent stratification may be required.

• Estimated cost approx $500K
•Summary of possible mitigation costs:

  Cold Box Replacement $10 M  
  Nitrogen Rejection/Tank Mod’s $ 5 M +  
  Tank Monitoring/Safety $0.5M  

  Total $15.5 M +

•Using this illustration, these expenditures represent more than 50% of either companies’ normal total annual capital expenditures….significant financial impact
CONCLUSION

• SCG/CNG will not be able to liquefy expected gas under the proposed AGT Tariff gas quality specifications with current equipment.

• The inability to liquefy gas is unacceptable because of the importance of LNG peak shaving in serving firm demand.

• Other New England LNG liquefaction plants will face most of the same issues.

• The proposed AGT tariff is not based on the historical gas quality these critical processes were designed for and have received.

• Existing and fully functional LNG liquefaction equipment will need to be abandoned and replaced.

• Absent certainty on C2/C3/C4 limits, mitigation cannot be designed.
Questions?