Gas Quality Impacts on LNG Liquefaction

Texas Eastern FERC Technical Conference December 8, 2009
Robert D. Wilson, Director, Materials & Standards, National Grid US Gas Operations
Why Is National Grid Concerned About NYC Peak Shaving?

- Texas Eastern is a major long haul supply source for the region – directly connected to NYC delivery systems.
- Over 1.5 million meters potentially impacted.
- LNG Peak Shaving critical to National Grid NYC energy infrastructure, provides over 20% of peak day supply.
- LNG trucking is not a viable option.
- Liquefaction is the only means to re-fill tanks.
A Little History

- LNG Liquefaction is directly impacted by changes in gas quality beyond which the facility was designed to receive.

- Recognized by NGC+ as a potential issue (Recommendation #10 and Finding#12).

- Each facility needs to be evaluated on a case by case basis.

- FERC has reconciled these issues of fact in recent rulings (AGT).

- Vast Majority of Reasonably Expected Global Supplies were addressed in the AGT Ruling Using the Interim Guidelines Coupled With a Broad Spectrum of Constituent Guidance.
NGC+ - Wobbe/HHV Alone May Not Be The Answer!!

Combustion Issues Addressed Via The Interim Guidelines

Interim Guidelines Include:

- Historical Wobbe +/-4%
- Capped at 1,400 + 1,110 HHV
- Butanes+ 1.5 %
- Total Inerts 4 %

- National Grid fully supports the interim guidelines as they were developed for use in combustion applications – However these guidelines DO NOT ADDRESS THE NEEDS OF LIQUEFACTION
Why Is Liquefaction an Issue?

- Plants were specifically designed around historically delivered gas

- Operation depends on concentration of specific constituents – each Plant requires independent assessment

- Not a typical end use “combustion” application…. Gas is “transformed” rather than consumed making this an Energy Infrastructure / Supply Security Issue for the Region
Typical Process Design Components

- Most Plants Incorporate a “3 Step” Process Including:

  **Purification** – removes impurities prior to refrigeration that may “freeze” – sensitive to CO2, moisture, sulfur, HDP, C6+ and other trace constituents.

  **Liquefaction** – Natural gas stream cooled via various thermodynamic processes to -260°F - sensitive to C2+, nitrogen, oxygen, other trace constituents.

  **Storage** – Liquefied natural gas stored in insulated tanks, boil-off gases re-introduced in the refrigeration cycle or distributed – sensitive to introduction of nitrogen, oxygen and liquid density differences.
Overview of Greenpoint Brooklyn Point Facility

- Natural Gas Open Expansion Refrigeration Cycle in service since 1969, liquefaction unit replaced in 2007
- 8.5 MM / Day Capacity
- 1.6 BCF Storage
- 240 MMSCF/Day Vaporization
- Not Equipped for Truck Fill Operations
  Prohibited by Law Within NYC
What Was The Design Basis For Greenpoint?

- Black & Veatch hired to model various compositions and provide plant redesign 2006/2007.
- Substitute gas compositions derived from data provided by Suppliers as “reasonably expected” for the northeast market area.
- Worked with Texas Eastern and other regional Pipelines to confirm blends of gases that could be expected based on “book end” compositions provided by Suppliers.
- Examined Specific Impacts of Increased Non-Methane Hydrocarbons, Nitrogen and Oxygen
- Assumed “Bookend Compositions” in Evaluation Including the Original Design and a High C2 Hydrocarbon LNG Import Similar to NGC+
New Plant Can Operate Within Proposed TETCO Tariff

- Total Plant Cost Approximately $60MM
- New De-ethanizer To Ensure Plant Can Accommodate Swings In Composition Without Impacting Product Density
- New Tail Gas Handling Strategy To “Blend Away” excess C2+ Up To 12% While Meeting NGC+ Interchangeability Guidelines.
- Redesign Considered That Tank Systems Are Not Subject To Change at This Point In Time.
Gas Composition Comparison – New Plant “Flexible” To Accommodate Reasonably Expected Supply Changes

<table>
<thead>
<tr>
<th>Original Operating Criteria (%)</th>
<th>New Operating Criteria (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane 93.36</td>
<td>85 - 93</td>
</tr>
<tr>
<td>Ethane 3.91</td>
<td>2.6 – 11.8</td>
</tr>
<tr>
<td>Propane 0.80</td>
<td>0.6 – 3.4</td>
</tr>
<tr>
<td>Butanes 0.13</td>
<td>0.33 – 0.963</td>
</tr>
<tr>
<td>Pentanes 0.04</td>
<td>0.15</td>
</tr>
<tr>
<td>C6+ 0.03</td>
<td>0.1</td>
</tr>
<tr>
<td>CO2 1.10</td>
<td>1.5</td>
</tr>
<tr>
<td>Oxygen 0.0</td>
<td>0.001</td>
</tr>
<tr>
<td>Nitrogen 0.60</td>
<td>1.5 – 2.75</td>
</tr>
<tr>
<td>Water 0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>HHV 1033 Btu/scf</td>
<td>1110 Btu/scf max</td>
</tr>
<tr>
<td>Wobbe 1346</td>
<td>1400 max</td>
</tr>
</tbody>
</table>
Let’s Learn From History………………

- Neither Dominion or Statoil Experts Up To This Proceeding Have Challenged The Technical Basis of Concerns Regarding C2+ and N2 impacts on peak shaving operations (see their expert testimony in Docket No. RP07-504-000)

- Some are of the opinion in this case that all liquefaction plants are capable of operating regardless of constituent specifications with assumed “minor modifications” – simply not true as recognized by NGC+ and in the recent AGT case.

- Expert testimony in a number of related Dockets all confirm “each plant needs to be considered individually”

- General thermodynamic modeling was used by NGC+ to demonstrate that impacts do indeed occur however broad conclusions to the contrary are misleading and cannot be applied to every plant design.
Conclusion

- National Grid Supports The Texas Eastern Proposal.
- The Proposal balances the need to maximize supply flexibility while assuring safety & reliability of the system.
- National Grid has invested over $60 MM to ensure continued reliable operation of our critical LNG asset in Brooklyn in an effort to allow additional supply composition flexibility – designed around accommodating the vast majority of reasonably expected global supply.
- The Texas Eastern Proposal facilitates “interconnectivity” of other critical regional pipelines that supply National Grid and other National Grid peak shaving facilities.
- Language exists within the proposal to allow flexibility for “non-conforming” supplies so long as the pipeline can manage aggregation of these supplies.