Gas Interchangeability: A Generator’s Perspective

Presentation by FPL Energy, LLC, owner of a generating plant in Bellingham, Massachusetts
Why Are We Here?

• On June 29, 2007, Algonquin filed revised tariff sheets consistent with the Policy Statement on gas quality and interchangeability.
• On July 30, FERC issued an order setting the proceeding for a technical conference in which (1) Algonquin should be prepared to explain how its proposal differs from the Interim Guidelines, and (2) any party proposing alternatives to Algonquin’s proposal should also be prepared to support its position with adequate technical, engineering, and operational information.
• This presentation will show that the +/-4% Wobbe Index range in the Interim Guidelines will cause technical, engineering and operational issues for FPL Energy’s generating plant in Bellingham, Massachusetts.
• While better, even Algonquin’s proposed +/-3.17% Wobbe Index range could cause technical, engineering and operational issues for FPL Energy’s generating plants.
Commission’s Policy Statement in Docket No. PL04-3: Interchangeability Specifications Should Be Based on Technical Requirements

• Only interchangeability specifications contained in a Commission-approved gas tariff can be enforced;
• Pipeline tariff provisions need to be flexible to allow pipelines to balance safety and reliability concerns with the importance of maximizing supply;
• Pipelines and their customers should develop gas quality and interchangeability specifications based on technical requirements;
• In negotiating technically based solutions, pipelines and their customers are strongly encouraged to use the Natural Gas Council Plus (NGC+) interim guidelines as a common reference point for resolving gas quality and interchangeability issues; and
• To the extent pipelines and their customers cannot resolve disputes, the Commission will resolve them on a case-by-case basis.
Commission’s Policy Statement in Docket No. PL04-3: Specifications Based Upon Sound Technical, Engineering and Scientific Considerations

- “Given the areas of additional research that is required, it would be premature to take more prescriptive actions such as prescribing gas quality and interchangeability standards or prescribing specific levels of the constituent elements of, or the heating values for, the natural gas transported in pipelines.” Policy Statement at P 27

- “[P]ipelines and their customers should develop gas quality and interchangeability specifications. The Commission expects that specifications for natural gas quality and interchangeability will be based upon sound technical, engineering and scientific considerations.” Policy Statement at P 31
Commission’s Policy Statement in Docket No. PL04-3: Developed a Process for Arriving at Interchangeability Specifications

• “[I]n negotiating technically based solutions, pipelines and their customers are strongly encouraged to use the NGC + interim guidelines as a common scientific reference point for resolving gas quality and interchangeability issues. The interim guidelines suggest a process for applying scientific principles to individual markets but do not address the specifics of individual pipeline circumstances or tariff provisions.”

• “Furthermore, the interim guidelines recognize that additional research and development are needed to arrive at more clearly defined limits to interchangeability specifications and to address the need for better and more timely operational information on natural gas quality and pipeline operations. The Commission’s policy will keep step with improved knowledge on gas quality and interchangeability.” Policy Statement at P 32.
Commission’s Policy Statement in Docket No. PL04-3: Process Should Involve Analysis of the Specific Limitations of the Pipeline and End Users

- “In application, either of the two methods suggested by the NGC+ task group offers a process for arriving at appropriate limits for the interchangeability characteristics of natural gas that may be accepted for transportation by a pipeline. However, the limits themselves must be derived to fit within the specific circumstances of each pipeline.”
- “The appropriate interchangeability specifications for different pipelines may vary depending on a number of factors, including: the historic characteristics of natural gas delivered by the pipeline to the markets it serves; local market practices for the use of target or adjustment gases used to install and adjust equipment in that market; historic variability in the characteristics of gas delivered to the market; whether there are customer loads with special gas quality requirements, such as a large process gas user; the type and gas quality tolerances of the end-use equipment (including “legacy” equipment); and, the tariff requirements of downstream pipelines.” Policy Statement at P 38.
Photograph of Bellingham Plant
Description of Bellingham Plant

• Combined Cycle Power Plant – 300 MW Nominal Capacity
  – Fueled by natural gas
  – Directly connected to Algonquin Gas Transmission, LLC

• Commercial Operation – began September 1991

• Two Westinghouse 501D5 Combustion Turbines
  – NOx Control via Steam Injection

• Two Nooter Erikson Heat Recovery Boilers (HRSGs)

• One Mitsubishi Steam Turbine Generator

• GEA Air Cooled Condenser (ACC)
  – 16 Cells
Description of Bellingham Plant (cont.)

• Merchant Facility – NEPOOL Market Region

• Originally permitted as a QF Cogeneration Facility with CO2 extraction

• Zero discharge facility – waste water is cleaned before it leaves the site

• Largely serves summer peak market, and is commercially available throughout the year
Facility Permit relating to NOx

- NOx Emissions Permit limit is 25 ppm @ 15% O2.
- Bellingham currently runs close to its compliance limit at 24.7 ppm.
- Bellingham will need to modify the steam injection valve sizes to change the steam injection rate in order to control NOx if any additional gas variability occurs.
- The GTI Report shows that the Bellingham unit “will require a controls retrofit if any additional variability occurs,” with a potential expected cost of $1.5 - $2 million per turbine, for a total cost of $3 to $4 million.”
- Bellingham has “uncontrolled” NOx – if emissions go up, Bellingham does not have a selective catalytic reduction (SCR) combustion treatment system to convert NOx. Addition of an SCR would require new boilers at a cost of $24-25 million.
Siemens Gas Index (GI)

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GI = \frac{\text{LHV}_{\text{vol}}}{\sqrt{\text{SG}^*}}
\]

GI = WI ÷ 1.109

1.109 is typical HHV/LHV ratio

- Siemens Power Corporation utilizes Gas Index which is the ratio of the lower heating value of the fuel to the square root of the temperature corrected specific gravity.
- The Gas Index is calculated using the temperature at the fuel nozzle inlet.

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\text{LHV}_{\text{vol}} = \text{lower heating value in BTU/scf}
\]

\[
\text{SG}^* = \text{fuel gas density at temperature of the nozzle inlet with density of air at standard conditions of 59°F, 1 atmosphere.}
\]

- This index is useful in determining the acceptability of a gas for a given application. For example, differing gases with the same index can be used without requiring a fuel nozzle orifice size change.
Gas Index Limits with Conventional (Diffusion Flame) Combustors

• The Westinghouse gas fuel specification for this unit:
  – states on page 1, “once a gas is defined for a specific application, day-to-day variations from a control point of view should not exceed +/-2%.”
  – This is because once a gas is defined for starting; the minimum gap is set for the gas fuel throttle valve to provide the correct ignition flow for the turbine. If the gas index varies too widely, adequate heat input may not be attained for ignition.
  – Total Sulfur is limited to $\leq 0.5 \%$ (weight). Hydrogen sulfide is limited to 5% (mole percent) maximum.
  – Oxygen should be limited to 2 to 9 ppm.
  – No liquid hydrocarbons must be present.
Variation in Gas Delivered

- Variation in fuel delivered can result in:
  - Failure to light off (start-up)
  - NOx too high = exceeding permit = shutdown
  - NOx too low = flame out and unit trip
  - Wobbe out of limits or abrupt heating value change = unit runback or uncontrolled load pick up
- If NOx Emissions Permit limit is exceeded, Bellingham would have to drop load or risk fines.
- A drop in load will have a huge financial impact on Bellingham’s ISO capacity payments.
Minor increase in NO\textsubscript{x} emissions with increase of Wobbe Index from 1335 to 1400, a range that would account for addition of LNG from offshore supplies.

Reported Fuel Effects on NO\textsubscript{x}

Full-scale engine testing confirms rig testing that, without burner modifications or engine control enhancements, increasing Wobbe Index can result in increased NO\textsubscript{x}.

From Siemens presentation at GTA
Gas Quality Stakeholders’
Technical Committee Meeting

August 9, 2005

Natural Gas Quality:
Power Turbine Performance
During Heat Content Surge

William Walters
Aspen Environmental Group

Sponsored by the California Energy Commission
Summary of Findings

• Uncontrolled NOx emissions increase with increasing natural gas heat content number, but that increase is different for each turbine.
  • Controlled NOx was not found to increase, the emission controls were able to compensate
• Additional ammonia was used for the gas turbines with Selective Catalytic Reduction in order to compensate.
  • Additional data is necessary to determine the full impact to the natural gas fired power plants.
• A study will be published in draft form for comment sometime in the next month.
Uncontrolled NOx Emissions vs. Heat Content

Sutter Turbine 2

Redding
Siemens’ Recommendations to FERC

• Siemens’ June 8, 2005 Comments in Docket No. PL04-3:
  – Recommend adoption of a +/-2% Wobbe Index range;
  – Recommend a limit on propane of 2.5%;
  – Recommend a limit on butanes + of 1.0%;
  – Recommend a limit on rate-of-change of the Wobbe Index of 2% per minute; and
  – Recommend a mechanism to assign cost recovery of equipment failures that are traceable to gas quality issues.
Conclusion

• Bellingham’s current gas quality specifications require a +/-2% Wobbe Index limit.
• This range of variation is consistent with historical gas supplies.
• A wider variation in fuel delivered can result in an increase in uncontrolled NOx.
• If NOx Emissions Permit limit is exceeded, Bellingham would have to drop load or risk fines.
• A drop in load will have a huge financial impact on Bellingham’s ISO capacity payments.
• If any additional gas variability occurs, Bellingham will need to modify the steam injection valve sizes to change the steam injection rate in order to control NOx, with a potential expected cost of $1.5 - $2 million per turbine, for a total cost of $3 to $4 million.