Will turbines require expensive retrofits to handle imported LNG?

With domestic reserves of natural gas declining and demand for gas rising, imported liquefied natural gas will increasingly fill the shortfall in U.S. pipeline supply. More than 40 LNG receiving/regasification terminals on three coasts are in various stages of development. Yet many questions about the operational and emissions impacts of the "hotter" LNG imports on today's cleaner-burning gas turbines remain unanswered.

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As the regulator of U.S. natural gas pipeline networks, the Federal Energy Regulatory Commission (FERC) has decided that increasing imports of liquefied natural gas (LNG) is the best way to increase gas supplies and moderate prices. Five years ago, LNG capacity in the U.S. totaled 4 billion cubic feet per day (bcfd). Between 2002 and 2006, FERC authorized an additional 12 bcfd of LNG capacity, and last June—in a single day—the agency authorized new LNG projects totaling an additional 9.7 bcfd. LNG imports are projected to increase at a whopping 16% annual rate through 2025.

Although FERC has encouraged the development of new LNG receiving terminals, it has been slow to address the significant operational and environmental problems created for gas-fired generators by the introduction of imported gas into existing U.S. gas transmission and distribution networks. In a nutshell, the problem for generators is this: Imported LNG has much different quality specifications than the domestically sourced natural gas they are accustomed to burning.

Is hotter better?

In general, imported LNG has substantially higher Btu content than domestic gas. As a result, for each new proposed LNG terminal, FERC must consider the extent to which the new project's output will be interchangeable with supplies already in its delivery pipeline, as well as the impact that the mixing will have on end users, especially combustion turbines.

One commonly used measure of this interchangeability is the "Wobbe Index," which is based on the heating value and specific gravity of the gas. A 1992 survey revealed that most domestic gas was between 1,331 and 1,357 on the Wobbe scale; however, it also showed that not all gas within this range was interchangeable. What's more, the study found that in specific regions of the country, the Wobbe range was much tighter. Imported LNG has higher Wobbe indices, with a maximum typically exceeding 1,400.

Manufacturers of gas turbines designed a unit's components (especially its fuel nozzles) based on the historical Wobbe Index range of its intended site. Introducing LNG with a higher Wobbe Index into a site's supply pipeline will often necessitate replacing old nozzles with new ones—at considerable cost—to optimize combustion and emissions performance.

FERC addresses the issue

All gas supplies, regardless of origin, are required to conform to a pipeline's quality specifications set forth in a FERC-approved tariff. Each pipeline operator establishes its own terminology, standards, controls, and conditions for establishing that its supplies are "pipeline quality."

This system worked well until gas prices began to rise in the 1990s. Domestic gas suppliers had stopped removing natural gas liquids (butane, propane, and ethane) from the gas stream with the intent of selling them separately. Instead, with the price rise, it became more profitable to leave those liquids in the gas stream. This increased both the Btu content of the gas stream and the potential for liquid hydrocarbon dropout while the gas was in transit. Hydrocarbon liquid dropout can cause O&M problems for pipelines and also damage gas turbine-generators.

Awareness of these new gas quality problems grew with proposals to build dozens of LNG terminals that would produce gas of higher heating value. To address the problems, and to "lower a potential barrier to

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expected increases in LNG imports," FERC concluded that it needed to update its gas quality and interchangeability standards. On June 15, 2006, the commission did just that with its Policy Statement on Gas Quality and Interchangeability.

The policy statement did not establish fixed nationwide gas quality standards to replace the existing standards—the pipeline tariffs. Instead, FERC delineated five principles, or guidelines, for case-by-case revisions to each pipeline's quality specifications.

As one of these five principles, FERC "strongly encouraged" parties to use the numerical guidelines of the Natural Gas Council Plus (NGC+) as a common scientific reference point for resolving gas quality and interchangeability issues. The two NGC+ reports (one on interchangeability and one on hydrocarbon liquid dropout) were prepared by an industrywide working group under the auspices of the Natural Gas Council and filed with FERC in early 2005. These two reports offered findings and recommendations, detailed a process for further research on these issues, and set forth interim guidelines for use pending the completion of additional studies and research.

No data? No problem

The NGC+ interim guidelines proposed using a range of ± 4% of the pipeline's historical, local average Wobbe Index, not to exceed 1,400. However, one of the NGC+ reports qualified the use of its interim guidelines by owners of gas-fired combustion turbines—especially newer dry low-emission (DLE) models—by noting that "[t]here are limitations to the applicability of the Wobbe Number, and additional specifications are required to address combustion performance, emissions and non-combustion requirements."

This report also pointed out that the research into managing interchangeability on which the interim guidelines are based may not even apply to low-emission combustion technology. It said that additional research was required "to define the compositional limits of natural gas to support development of longer-term interchangeability guidelines for low emission and high efficiency combustion designs." Most importantly, the NGC+ report stressed that the guidelines should be used during a transition period of no more than three years, during which existing data gaps should be closed.

To date, there has been only one case heard by FERC in which the NGC+ interim guidelines and the commission's policy statement were applied in a real-world setting to derive pipeline-specific quality guidelines. In 2004, AES Ocean Express LLC (AES) filed a complaint against Florida Gas Transmission Co. (FGT) regarding the gas quality and interchangeability standards to be applied to the LNG regasified by AES at its terminal in the Bahamas and injected into the FGT pipeline. In April 2006, a FERC administrative law judge (ALJ) approved FGT's proposed standards, subject to a final FERC determination, which remains pending.

The ALJ relied heavily on the interim guidelines in finding that FGT's proposed Wobbe range of 1,340 to 1,396 would permit the safe operation of all existing DLE combustion turbines fed by its pipeline. More significantly, however, the judge determined that he had a sufficient factual record to support the imposition of permanent gas quality and interchangeability standards on FGT, even though there was no research to document the impact of such limits on DLE combustion turbines.

LNG suppliers have criticized the decision for the ALJ's refusal to just adopt the NGC+ interim guidelines. In doing so, LNG suppliers elevated the NGC+ report's interim

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guidelines and the accompanying preliminary recommendations and findings into "a consensus recommendation of the natural gas industry that resulted from a Commission-initiated process."

Gencos operating gas-fired plants have also taken issue with the decision because of its selective reliance on limitations spelled out in the NGC+ report. They also criticized the ALJ's decision to entirely discount evidence documenting that the wide design specifications for DLE turbines are substantially narrower in actual operating conditions.

Considerable cost consequences

This evidence demonstrated that although a DLE combustion turbine can burn gas with a relatively wide Wobbe Index range, once it is installed and tuned to burn gas of a specific Wobbe Number, its actual safe operating range is likely to be substantially narrower. The ALJ appears to have both misunderstood portions of this evidence and discounted those aspects that he understood, because it was "preliminary only." As a practical matter, in the fall of 2005 (when the AES hearing was under way), there was scant scientific research available on the real-world effects of variability on the operation of DLE turbines.

Although it is impossible to predict how FERC will rule on the ALJ's preliminary decision, a FERC ruling endorsing the ALJ's approach could have substantial adverse economic implications for operators of DLE turbines nationwide. Evidence presented during the hearing indicates that retuning a DLE turbine for peak performance on gas of a different heating value can cost as much as $25,000 to $50,000. Such retuning is labor-intensive, may take several days, and—if units are part of a fleet at multiple sites—may be logistically problematic.

Evidence presented also showed that if a DLE turbine will routinely have to switch between domestic and imported gas supplies, manual retuning may be impossible. Instead, the unit may require a much more costly (and as yet unperfected) retrofit for automatic retuning, at an estimated cost of between $1 million and $5 million per turbine. Finally, the evidence showed that such fluctuations can adversely affect a unit's operational stability and ability to meet increasingly tighter air pollution standards. Ultimately, the variability could cause a plant to violate its air quality permit, make trips more frequent, and/or cause catastrophic damage to its turbine.

Similar concerns about imported LNG's potential impact on air quality also have been raised by environmental groups. Several have challenged the adequacy of FERC's analysis of the environmental impact of import of LNG and transport of regasified LNG by and from a terminal in Baja California owned by Sempra Energy. All of the groups contend that FERC has an obligation to more thoroughly vet the effect of the "hotter" gas on air quality.

Most recently, in a Natural Gas Pipeline Co. of America (Natural) proceeding, FPL Energy LLC (FPL Energy) raised concerns regarding Natural's proposed gas quality standards (again modeled on the NGC+ interim guidelines) because its newer DLE combustion turbines, which are fed by Natural's system, are more sensitive to fuel gas quality changes than conventional diffusion-flame units. FPL Energy alleged that allowing a wider Wobbe Index range on the Natural system, as the pipeline proposed, may prevent these units from operating as designed.

Follow the money

The NGC+ numerical guidelines were presented as interim in nature and were offered with the explicit caveat that additional research is needed on a range of issues, including impacts on DLE combustion turbines. However, FERC's adoption of the guidelines in the June 2006 policy statement validates them and potentially extends their applicability well beyond the proposed three-year term. For evidence to support that conclusion, consider that the ALJ in the AES case recommended making permanent FGT's new gas quality standards, which permit a wider Wobbe Index range patterned on the interim guidelines.

Gencos seeking narrower Wobbe Index ranges to better accommodate DLE combustion turbine operations will be unlikely to convince FERC of that need without firm documentation that greater fuel variability adversely impacts turbine operations and/or air quality. It is unclear whether gencos would have any recourse against a turbine manufacturer, for example, if the variability were to result in a violation of a site's air quality permit, even though the pipeline supply was consistent with newly broadened quality specifications.

It is unlikely that most pipelines will seek to maintain narrow gas quality specifications. Some are already affiliated with companies that have a substantial economic stake in encouraging increased LNG imports. For example, FGT, the pipeline at the center of the AES case, is partially owned by Southern Union Co., which in turn owns the FERC-approved Lake Charles, La., regasification project. Each new LNG import project—whether on the West, East, or Gulf Coast—creates an opportunity for a profitable expansion of the existing, local pipeline network. Such is the case with the North Baja Pipeline's current expansion, which is designed to transport regasified LNG from Sempra's terminal in Baja to demand centers in California and Arizona.

The dollars at stake are enormous. The new tankers and regasification facilities needed to increase imports of LNG over the next 15 years will cost $130 billion to build. Financing the ships and plants will prove

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lucrative to Wall Street, which over the past decade has emphasized ever more vocally to FERC the importance of encouraging energy infrastructure development. Partially as political fallout from the California electricity crisis of 2000/2001, FERC has prioritized such development as a way to bring new supplies to market and thus stabilize energy prices. Against this backdrop, in the absence of concrete evidence of harm to end users, expect FERC to endorse pipeline quality specifications patterned on the NGC+ interim guidelines. Once approved in pipeline tariffs, these interim guidelines could easily become permanent.

More research needed

If owners and manufacturers of DLE combustion turbines hope to avert this outcome, they need to spend the time and money necessary to document and substantiate what today remain hypothetical concerns and anecdotal evidence of adverse impacts on end users. The ALJ's discounting of preliminary studies in the AES proceeding suggests that additional research is essential to examine the real-world impacts on gas turbine operations of a full ±4% Wobbe variability, along with other aspects of the NGC+ interim guidelines.

An October 2006 study by the DOE's National Energy Technology Laboratory (NETL) raises concerns about impacts on DLE gas turbines. While suggesting that the Wobbe Index is not an adequate indicator of the performance of this sort of turbine, the study neither quantifies the impacts nor critiques the NGC+ interim guidelines.

If NETL conducts another study of this issue, it is crucial that both the manufacturers and users of DLE combustion turbines directly monitor or participate in the effort to guarantee its objectivity—especially if other nongovernmental groups are consulted. The inconclusive October 2006 NETL study lists only the Natural Gas Supply Association (a gas producer group seeking relaxed pipeline gas quality standards nationwide) as providing it with "industry support." Privately sponsored studies by manufacturers and utilities would also be useful.

The NGC+ report recognizes that overly broad limits on interchangeability specifications may well result in reduced reliability, increased emissions, and decreased safety of DLE combustion turbines, as well as higher electricity costs for consumers. At the same time, it points out that unduly conservative interchangeability specifications may serve to constrain supply, which likewise would raise retail power prices.

The report also states that interchangeability is usually best managed either at the origin of supply or prior to delivery into a pipeline. However, FERC sidesteps the issue of cost responsibility by rejecting requests by end user groups that pipeline operators be required to guarantee the "merchantability" of the product they transported. Thus, unless DLE turbine makers and users can document the adverse impacts of fuel variability and use the evidence to persuade FERC to modify the approach in its June 2006 policy statement, ultimately they will be the ones likely to bear the potentially significant costs of that variability. ■

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