LNG QUALITY AND THE UK GAS MARKET

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ABSTRACT

The changes in the LNG business since the first commercial cargos back in 1964, mean that the UK now competes for LNG supply that has a number of alternative markets in the Atlantic Basin. In particular the UK is in competition with the US markets that have similar gas quality constraints.

However, with changes in the UK gas spec now ruled out by the UK Government in the short to medium term, the challenge of attracting LNG supplies to the UK that meet the local gas quality constraints will remain for the foreseeable future. As the UK becomes more reliant on imported gas supplies it is important that the UK gas business stays ahead of the alternative markets to ensure competitive supplies of gas are attracted to the UK market.

Installing LNG quality adjustment equipment at Grain was necessary to maximise importer's ability to attract LNG supply from the widest number of sources available.

Providing cost effective gas quality adjustment equipment to meet the full range in potential LNGs, whilst maintaining the flexibility to meet market demand, requires a combination of both capital investment plus variable costs to cover short term peak demands.
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1. INTRODUCTION

Declining North Sea production has resulted in LNG being brought to the UK again after a 20 year gap and the start-up of the Isle of Grain LNG Import Terminal in the summer of 2005 represented a fundamental change in the UK gas market.

The UK was the first commercial importer of LNG over 40 years ago, but since that time the LNG business in the Atlantic Basin has matured to the point where LNG supply is not necessarily tied to specific markets.

This new flexibility means that LNG from many different sources may be attracted to the UK gas market however, the very lean UK gas spec is a potential constraint when considering LNG supplies for the UK.

The award of the first phase of LNG import capacity, 3.3 mtpa, at the Isle of Grain Terminal to BP and Sonatrach brought the challenge of meeting current gas quality limits in the UK within a tight project schedule requiring close co-operation between both the terminal, the capacity holders, and the nitrogen vendor.

2. BACKGROUND

In October 2003, BP/Sonatrach were jointly awarded LNG import, storage and regas capacity of around 3.3 mtpa at the Isle of Grain terminal in south-east England. The contract term commenced in July 2005.

BP and Sonatrach together have firm contractual rights to utilise the Grain terminal’s jetty to berth and unload LNG cargoes, temporarily store LNG and nominate the send out of regassified LNG to the high-pressure national transmission system (“NTS”). Each day boil-off gas from the LNG storage tanks, or from LNG tankers when unloading, is released into the lower pressure local distribution zone.

National Grid Grain LNG Limited, a subsidiary of National Grid plc is responsible for all operations associated with the terminal including the provision of berthing, storage and regas services, scheduling of terminal maintenance, procurement of utilities and any gas blending necessary to meet the UK gas specification. The LNG import terminal was converted from a peak shaver LNG facility that was in operation from 1982 to 2005.

3. LNG QUALITY

LNG quality can be considered reasonably consistent from a given LNG plant with heating values varying by typically less than 4% and wobbe numbers typically less than 2%. This is rarely reflected in the agreements which are used for the commercial contracts between the buyer and the seller. These typically contain ranges of between 8 and 10% on heating value, although this information sometimes needs to be inferred from other specifications.

To illustrate, the following plot shows the upper and lower limits of a typical agreement compared with the quality experienced from a number of cargos. The plot also shows the effect of adding nitrogen required to meet the UK gas specification. This large margin of comfort in the commercial agreement means that designing the receiving facilities to cope with this uncertainty is sometimes difficult to justify.

*Figure 1 – Effect of Nitrogen on Wobbe No. for a Typical Lean LNG Specification*
It can be seen in this case that the typical lean cargo almost always meet the UK spec with little or no ballasting. However, with the maximum contractual limits the theoretical LNG quality could require as much as 3% nitrogen to meet the UK spec. This illustrates the problem in determining realistic data for use in designing gas quality adjustment facilities at import terminals.

The following figure shows typical ranges in LNG qualities from various worldwide supply sources. Any of these LNGs could enter the UK gas market sometime in the near future provided the facilities are available to treat them. It can be seen, however, that almost without exception they are outside the current UK gas specifications on wobbe alone.
The above represents the composition of LNG on arrival in the UK having taken account of weathering during the voyage.

Depending on the source of LNG, and more specifically the amount of nitrogen in the loaded LNG, this can have a discernable impact on the LNG arrival quality. The following figure shows the predicted change in heating value for a typical Middle Eastern source arriving in the UK. For LNG cargos with lower nitrogen contents this effect is less pronounced although it still needs to be considered when estimating the arrival composition at a particular destination.
The change in composition over the voyage depends on many factors but the most significant is the loaded nitrogen concentration. The following plot shows the effect of voyage time on the nitrogen content of the LNG. When a loaded cargo contains significant concentrations of nitrogen the change in nitrogen over the voyage can have a significant impact on the arrival composition, hence quality.

**Figure 3 – Effect of Nitrogen on LNG Weathering**

![Loaded and Discharge HHV vs Nitrogen content - Typical Middle East LNG](image)

**Figure 4 – Nitrogen Change vs. Journey Time**

![Nitrogen Change vs Journey Time](image)
It is clear that understanding the range in quality of the LNGs and factors that affect the quality are critical in determining the gas quality adjustment requirements at the import terminal. However, it is equally important to understand the market and the likelihood of a particular LNG being attracted to the UK. Understanding the potential sources of LNG and its associated quality characteristics and the market were important factors in determining the gas quality adjustment requirements at the Isle of Grain.

4. GAS QUALITY ADJUSTMENT

Ensuring fit for purpose gas blending measures were in place for the terminal start-up was a significant challenge that was achieved by close co-operation between all parties.

The key technical challenge was to find a suitable solution to the gas specification restrictions applying to a wide range of LNG sources. This was necessary in order for BP to achieve its commercial objective of sourcing a wide variety of LNG’s and maximise utilisation of BP’s terminal capacity rights.

Options that were taken into consideration when reviewing gas quality were:
- Likelihood of the HM Government legislating a changes to the UK gas specification
- Gas blending / mixing with NTS gas
- Ballasting with nitrogen

4.1 Possible changes to the UK Specification

The debate on LNG supply returning to the UK after a 20 year absence, and the potential gas quality issues were just starting to gather momentum during 2003. However, it soon became apparent that with many differing views and interests from various parts of the gas industry an early change in the UK gas specification was unlikely.

This was confirmed in June 2004 when a ministerial statement stated that there was ‘…no question of the Government recommending…..to implement an early change in the UK’s gas quality regulations’.

It went on to say that the current research was expected to confirm either no change, or transitional measures to effect a change towards the end of the next decade, i.e. 2020, was the most likely outcome.

Although the UK government recently confirmed that the preferred option is ‘no change’, further consultation with the gas industry mean that it is keeping open the option of a possible future change, although this is more likely to be driven by future changes in appliance design and combustion technology.

4.2 Gas blending / mixing with NTS gas

The option of pipeline gas mixing was considered.

There were several issues associated with this not least of which was that significant new infrastructure would be required to guarantee effective gas blending before the gas was allowed to enter the NTS. This would require further studies to evaluate the feasibility of such a scheme and there was still no guarantee of a potential solution.

Furthermore, for this solution to be feasible it would require significant volumes of ‘on spec’ gas with which to blend and given the Isle of Grain’s proximity in the South East corner of the UK this could not always be guaranteed.
4.3 Nitrogen Ballasting

Ballasting with inert gas provided the only practical solution to gas quality adjustment at the Isle of Grain. Following discussion with a number of vendors to determine which technical options were appropriate, the project went out to bid around 3 months after the award of the capacity at the terminal.

The preferred strategy was for a ‘build, own, operate’, BOO, type of contract. It was also felt that using a specialist industrial gas supplier, with their experience and technical back-up, offered less risk to a build only solution.

5. FINAL SOLUTION

5.1 Design Basis

A contract was awarded to Air Products in early June 2004 for a two phase development. The long-term contract made Air Products responsible for building, operating and maintaining a nitrogen facility with an option to extend the arrangement at the end of the initial contract period. The nitrogen facility is located within the existing Grain boundaries and electrical power plus other site services are provided to the Air Products facility via the existing terminal facilities.

Due to relative short lead time between award of the Air Products contract and the expected start-up of Grain’s terminal operations in 2005 the parties agreed to fast-track the installation of liquid nitrogen storage and injection pumps. The “LIN phase” of the facility operations consisted of liquid nitrogen storage and cryogenic pumps capable to delivering liquid nitrogen at up to 90 barg. This provided sufficient facilities for an early plant start-up in 2005. Liquid nitrogen was supplied by Air Products by road tanker prior to the gaseous nitrogen plant being available.

The second phase consisted of a cryogenic nitrogen plant that produces gaseous nitrogen. This plant also produces small amounts of liquid nitrogen to top up the liquid nitrogen storage when not operating at full gaseous production rates.

With the gaseous plant operational the liquid nitrogen system acts as a back-up to the gaseous plant.

5.2 Operations

Prior to the availability of the gaseous nitrogen facility, the terminal has ensured that there has been sufficient level of liquid nitrogen available to achieve maximum gas send-out capability. During this period of time significant volumes of liquid nitrogen were used. This was only achieved by the excellent co-operation and effort of all parties concerned and in particular to the liquid nitrogen supplier who mobilised additional trucks and drivers from mainland Europe to support the liquid nitrogen demand.

The facility is manned during normal working hours with 24/7 remote back-up via telemetry to the main Air Products operations centre. Grain personnel have access to the facility in the event of an emergency, and can shut-down the facility from the main terminal control room.
6. CONCLUSION

Installing LNG quality adjustment equipment at the Isle of Grain was necessary to maximise importer’s ability to attract LNG supply from the widest number of sources available. However, the desire to maintain maximum flexibility, plus the uncertainly on LNG quality, led to the need to provide a flexible gas quality solution.

The final solution was a mix of long term commitment for on site nitrogen generation plus short term peak supply using trucked in nitrogen. Close co-operation of all the interested parties on both technical and commercial issues enabled the critical project schedule to be met whilst achieving the main objectives.