



LNG makes UK comeback

With gas demand rising and domestic production set to decline, the UK will need to import gas in the near future. LNG will fill part of the supply gap. The country's most advanced LNG-import project is the Isle of Grain terminal, where a peak-shave LNG storage plant is in the process of being converted into a base-load import terminal. Completion is set for January 2005. By Mark Johnson and Ian Belmore, National Grid Transco

SINCE the closure in 1994 of the world's first LNG import terminal, on Canvey Island, the UK has not had facilities for importing LNG. By the beginning of next year, that will change, when the conversion of National Grid Transco's (NGT) Isle of Grain peak-shave LNG storage facility to LNG receiving terminal is due for completion.

There are five peak-shave LNG storage facilities in the UK, strategically located across the gas transmission network, owned and operated by NGT. The Isle of Grain terminal, in the Thames Estuary, opposite Canvey Island, has a natural deep-water berth, is within 50 km of London and has an existing connection into the high-pressure gas transmission system. It is, therefore, ideally located for receiving LNG shipments.

The UK is undergoing a rapid change in its gas supply and that will continue over the next decade, as demand rises and indigenous production declines. It is estimated that additional gas supplies will be required from 2005, with up to 10% of UK supply being imported. By 2010, the UK is projected to import up to half of its gas demand. By 2020, imports may be as high as 90%.

NGT's role

NGT was formed in 2002 as a result of the merger of National Grid Group and Lattice Group. The merger formed an international energy-delivery business, with principal activities in the regulated electricity and gas industries in the UK and US. In the UK, it owns and operates the natural gas transmission and distribution system through its Transco subsidiary. NGT also owns and operates the high-voltage electricity transmission network in England and Wales, and the largest electricity transmission and distribution network in the New England/New York region of the US. The Isle of Grain is owned and operated by Grain LNG, a wholly owned subsidiary of NGT.

The Isle of Grain peak-shave LNG plant was commissioned in 1981 and has 200,000 cubic metres (cm) of storage space in four double containment LNG storage tanks. The send-out capacity is comparable in scale with many of the world's import terminals, with a peak send-out rate of 22m cm/d. The tanks are filled with LNG from two small liquefaction plants, an open-loop expander plant, which makes use of the high demand requirements for low-pressure gas in southeast England and a closed-loop nitrogen-expander plant, which gives the site the ability to produce LNG at any time of the year.

The installation has a typical peak-shave configuration of slow fill-times and high send-out rates, taking 270 days to fill and only five days to empty the LNG storage.

The site has been in continuous operation since it came into service in 1981, providing LNG storage services both to Transco, as the system operator, and to gas suppliers in the UK. Because of the strategic location of the LNG site, even after imports commence, the Isle of Grain facility will still play an important role in the safety and integrity of the UK pipeline systems. During the conversion, the site is

Table 1: UK LNG import projects

Project	Milford Haven (Dragon) 2007	Milford Haven 2007	Isle of Grain 2005
Promoter/Operator	BG (50%), Petroplus (20%), Petronas (30%)	ExxonMobil, Qatar Petroleum	Sonatrach, BP
Source	-	Qatar	Algeria
Capacity (million t/y)	4.40	15.00*	3.00
Storage ('000 cm)	330	-	-

* By 2009

remaining operational, with only two of the four tanks being converted at a time. Following the commissioning of the import terminal, the existing liquefaction facilities will be fully decommissioned.

The challenges of conversion

In developing the Isle of Grain a number of significant commercial and technical challenges were overcome. The technical challenges consisted of: developing a robust and properly costed engineering proposal for the conversion; The decommissioning and revalidation of the LNG tanks within the project timelines; and construction while the plant remained in service.

On the commercial side, the challenges were: convincing the market that a shortfall of supply would occur and that LNG would be competitive against pipeline alternatives; demonstrating that the Isle of Grain site was the best site in the UK for LNG importation; setting up a fair and open process to sell the capacity of the site to the market; following the construction timetable in order to give the project first-mover advantage over rival projects; and ensuring a fair market price for the capacity sold.

The commercial process

The commercial processes started in mid-2002, with briefing presentations to key industry players. This gave them an outline of the supply side gap and the potential of the Isle of Grain and LNG to fill that gap. This step was critical in terms of allowing the market players sufficient time to carry out their own analysis of the UK market conditions before the capacity sale commenced in 2003.

Before the sale of the capacity could occur Grain LNG developed a set of General Terms and Conditions (GTCs), the commercial terms and rules that govern the commercial and physical operation of the terminal. These allow for multiple owners of the terminal capacity, with each owner having the rights to berth, unload, store and vaporise LNG at the terminal. The operator of the terminal has incentives to operate efficiently and act as a reasonable and prudent operator. The successful capacity owners are responsible for the purchase of pipeline capacity in the UK to ship their gas to the market and for selling the gas.

The second stage commenced in early 2003, with an industry-wide call for expressions of interest in capacity at



Mark Johnson



Ian Belmore

the Isle of Grain terminal. A proposals document was sent to over 25 companies. From this process, companies were asked for indicative proposals for the securing of the capacity and for comments on the GTCs for the sale and operation of the capacity. These comments were taken into account and a revised set of GTCs were issued to the shortlisted companies, which proceeded to stage three. This was for the provision of indicative bids for the capacity at the Isle of Grain.

The final stage commenced in July 2003 and involved the provision of firm, legally binding bids for the terminal capacity. Four companies were invited to enter the final round of the process, which included detailed negotiations.

This structured process had a number of advantages over the more traditional negotiated route. First, it ensured all interested parties had an equal chance of securing the terminal capacity. Second, key principles, which underpinned the GTCs, were set and these were enhanced and improved following comments received from the industry. Third, a firm and fixed timeline was followed, which enabled all participants to plan their response and ensure internal sign-off before submission. Upon completion, Grain LNG was able to demonstrate that it had the best offer available from the market for the service and that the process had been an open and competitive one.

The technical process

The technical challenges of the conversion relied on obtaining answers to fundamental questions as to the practicability of the conversion at a very early stage – much earlier than these issues would normally be addressed. For example, was it feasible to re-engineer the LNG tanks within the project timeline? This was critical to the success of the project. To answer these questions a pre-feasibility study was undertaken, where past studies on the Isle of Grain and new fundamental issues were examined. This study looked at the length of the unloading line (some 3.5 km), the rapid de-commissioning and re-commissioning of the LNG tanks, the capital cost of the modifications and the suitability of the existing equipment installed on the site for future base-load operation. The suitability of the marine approach to

LNG carriers and the attitudes of the local regulators were also considered, focusing on the safety and environmental aspects of the terminal. **ANY NEED TO MENTION ENVIRONMENTAL ASPECTS? DO YOU MEAN RESIDENTS NOT REGULATORS?**

This report highlighted no irresolvable issues and resulted in the project moving to conceptual design and initiation of the commercial processes.

Design of the import terminal

The design concept involves connecting the existing LNG storage facility to a new jetty through an above-ground unloading line, converting the existing tanks from peak-shave duty to being able to accept LNG from ships at far higher flow rates, installing new and more efficient LNG vaporisation equipment and larger boil-off gas compression to dispose of the flash gas accompanying the ship offloading.

The philosophy for the design is, where possible, to re-use the existing site plant and equipment, in order to minimise project costs and lead time, while ensuring a design life for the new terminal of 25 years. A major challenge for the project was therefore the modification and revalidation of the existing storage tanks for use in importation duty.

Modification of storage tanks

Four 50,000 cm, double-walled LNG storage tanks are installed. These peak-shave storage tanks are designed to be filled at 900 cm of LNG a day. This fill-rate is increased to 12,000 cm an hour on conversion to importation duty to ensure that a 138,000 cm ship can be offloaded in 12 hours. This step-change in fill-rates requires that significant adjustments are made to the connections to the tank, as well as to the instrumentation and safety systems. Furthermore, the modifications to the tanks, two of which were commissioned in 1979 and the other two in 1981, are to present standards, which has had a significant impact on the design.

Initially, it was hoped the tanks could be modified in service and the option of re-using existing nozzles on the tank for the faster fill-rates was extensively analysed during conceptual design. It was envisaged that three of the emer-

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Aerial view of the Isle of Grain site



gency relief valve nozzles could be used for fast filling, while upgrading the remaining nozzles to ensure adequate relief capacity. Ultimately, this method of tank conversion was deemed unacceptable because of inadequate heat breaks on the nozzle penetration and the potential of in-service failure because of vibration harmonics.

In view of this, and also to allow revalidation inspections to extend the design life of the tanks for a further 25 years, it was apparent that the tanks would have to be fully decommissioned and warmed up. This was well within the initial design parameters of the LNG tanks, with an allowance of six warm/cold cycles.

In addition, as the Isle of Grain was to continue to perform its role as a peak-shaving plant while the modifications were made in order to maintain security of transmission supplies, only two tanks could be decommissioned at any time. Furthermore, hydro-testing of the tanks after the modification needed to be avoided because of the complexity and cost involved. Therefore, no modifications to the tank internals, which would affect the integrity of the primary containment vessel, were to be undertaken that would necessitate a further hydro-test of the facilities.

Scope of works

The decommissioning of each tank would follow the following basic steps: pump out, warm up, purge to nitrogen, purge to air, isolation, initial tank entry, tank inspection and construction, de-isolation, drying and purge to nitrogen, purge to gas, cool-down and refill.

The modifications to the tanks are the provision of new 24-inch fill and boil-off gas lines (compared with the 3-inch fill and 12-inch boil-off lines presently fitted), an increase in the amount of available process pressure relief (to handle the fill case), the provision of three independent level measurement systems, an independent high-level trip system for overfill protection at the new fill rates, and additional fire and gas protection on the tank roof around the in-tank pumps and relief valves. The tank volumes were also to be recalibrated following the modifications.

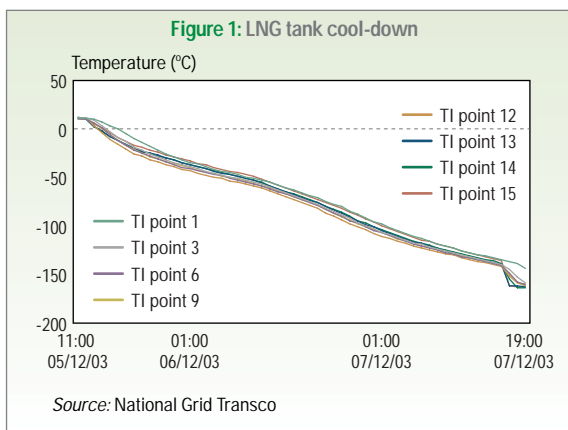
To meet the timescales of the project, a number of methods of reducing the time-frame for tank modifications were examined. Two areas of efficiency were examined in detail, namely reducing the warm-up times of the tank by supplying additional heat input and reducing the boil-off times by insertion of a temporary pump to reduce the level of LNG, following pump-out to a minimum (heel removal).

It was estimated that the heel of the tank would take up to six months to evaporate, jeopardising the project completion date of January 2005. A method for insertion of a temporary pump, pump down of the heel and removal of the pump was developed and utilised.

For the purposes of revalidation of the tanks to demonstrate that no part of the tank had warmed up at greater than 4°C per hour, it was decided that the tank would be allowed to warm up naturally.

Project progress

Decommissioning of the first tank was initiated in December 2002, with the tank level reduced to 380 millimetres (mm) by the in-tanks pumps. The temporary pump was inserted into the tank in January 2003, with the level reduced to below 35 mm. It was envisaged that the removal of the heel saved one month per 100 mm of heel removed, saving three and half months from the programme for each tank. This procedure was completed within two weeks, with no technical or health and safety problems, by a joint team from Grain LNG, Skanska Whessoe and Carters Cryogenic Services. This has subse-



quently been used successfully on a number of projects around the world.

During construction, the tank was fitted with new fill and boil-off gas lines, new pressure-relief systems and new level, temperature and pressure instrumentation appropriate to importation duty as well as additional fire- and gas-detection systems on the tank roof. In addition, while out of service, the first tank was inspected and revalidated for a further 25 years of design life and the in-tank pumps were removed, inspected, overhauled and returned.

The second tank was decommissioned in May 2003 and, by the end of November 2003, the modifications were completed on both tanks. The two tanks were then cooled down in December 2003 (see Figure 1). The LNG stock from the in-service tanks was pumped across to return the modified tanks to peak-shave duty. The other two tanks are now empty and warming up to allow modification. Base-load operation is to commence in January 2005.

The future

The conversion of the Isle of Grain will enable the terminal to accept 3.3m tonnes a year (t/y) of LNG. This does not, however, meet the expected market demand for LNG or utilise the installed assets to their optimum capacity. Therefore, a further expansion is being planned for the terminal with a second open season approach to the market to commence in early 2004.

Permit applications for up to an additional 0.57m cm of storage capacity held in three large total containment tanks, additional vaporisation and associated plant have been submitted. These applications are being evaluated and permits are expected to be granted in early 2004. This expansion would increase the capacity of the terminal to 10.5m t/y and could be operational for the winter of 2007.

The conversion and reuse of the existing peak-shave LNG storage tanks at the Isle of Grain will allow the base-load terminal project to be developed within two years from award of contract and four years from project conception.

The commercial process has secured a 20-year capacity contract from a BP/Sonatrach joint venture, while providing a demonstrably open and competitive process.

The expansion proposals for the Isle of Grain will ensure NGT and the Isle of Grain will be at the forefront of the development of the UK LNG market, ready to expand to meet the requirements of the UK gas market and help meet the shortfall in supply.

The construction of the site is well under way, with full commercial operation on schedule for first-quarter 2005. This fast-track process with pre-investment by NGT has ensured the Isle of Grain will allow the first large scale LNG imports to return to the UK after a 20 year absence. □