THE BRUNEI LNG PLANT - EXTENSION AND EXPANSION PROJECTS

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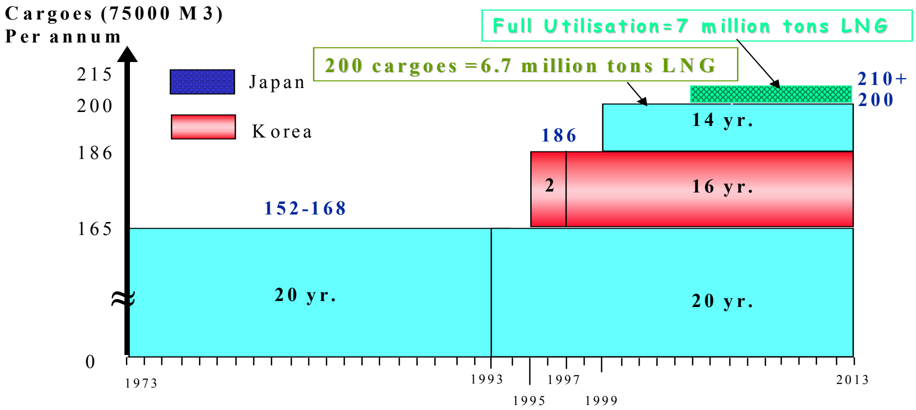
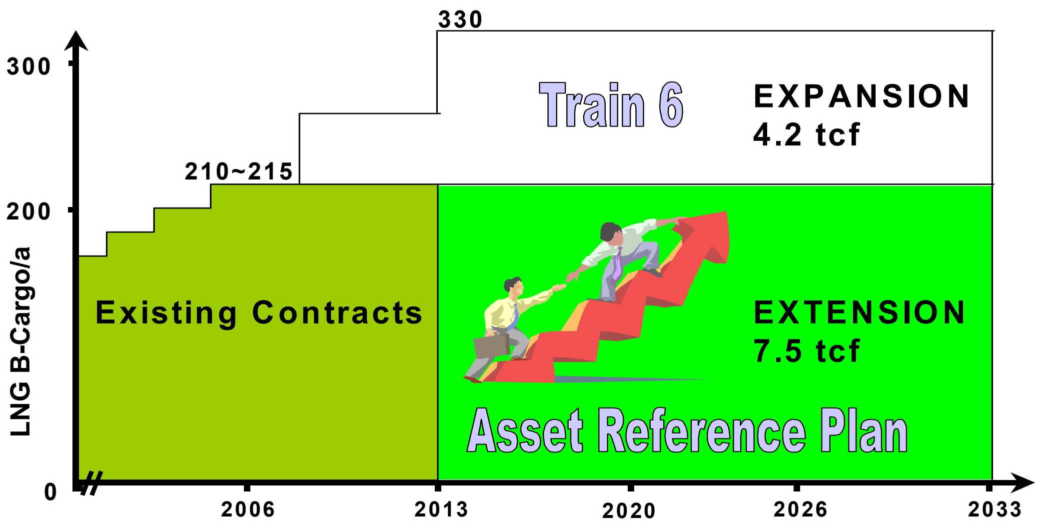
1. INTRODUCTION

Who doesn´t know where BLNG is located? For those –hopefully few- amongst us, the Brunei LNG plant is situated in Lumut, in the Belait District of Brunei Darussalam, where its coastal plot and four km long jetty face North towards the South China Sea. The plant was commissioned in 1972 and has recently celebrated its 30th year of operation. BLNG is a joint venture between the Brunei Government (50%), Mitsubishi Corporation (25%) and Shell Group (25% - also Technical Advisor).

BLNG is now in the middle of its second 20-year contract with customers in Japan and South Korea. In 1999 BLNG launched the Asset Reference Plan (ARP) campaign, which provides the technical and operational framework to stretch the lifetime of the plant with a third 20-year sales commitment till 2033 and to meet the aspiration of the BLNG shareholders for increased sales flexibility in the years ahead. Upon completion in 2008, the ARP will create maximum value from an aged but rejuvenated asset base, including an increase in its LNG production capacity of some 5 percent beyond its present production limits.



Current gas reserves studies indicate good confidence that the additional (non-committed) feedgas, necessary for the 20-year extension period 2013-2033, can be secured. Meanwhile, expectations of significant new gas reserves being found in future deep-water exploration offshore Brunei have prompted initial studies into a plant expansion project with a new, world-class LNG train. This new LNG train (Train 6 or T6 for short) would add some 4 MM tpa to the BLNG production capacity and deliver continuing market growth in the Asia-Pacific region and a further contribution of BLNG to the sustainable development of Brunei Darussalam.



In this paper the present BLNG plant configuration including major plant rejuvenation activities (ARP) are briefly discussed to set the scene for the main topic, a discussion of the technical options and challenges involved in an expansion of the BLNG plant with a state-of-the-art, sixth LNG train.

2. EXISTING CONFIGURATION

The existing plant comprises of 5 identical liquefaction trains, each capable of processing 5.3 MM m3 of gas a day, resulting in a total plant capacity of more than 7.6 MM tonnes of LNG per year. Each train comprises of an acid gas removal unit, a dehydration unit, a mercury removal unit and a liquefaction unit. In two Refrigerant Manufacturing Units (RMUs) the heavy feedgas components recovered in the five trains are split into individual components Ethane, Propane, Butane and Condensate (C5+) to make up the refrigerant supply for the Propane pre-cooling cycle and the Mixed Refrigerant main cryogenic cycle, with Condensate exported as crude oil component and excess refrigerant being reinjected into the liquefaction process. A small part of the Propane is sent to an adjacent bottling plant to serve the domestic cooking gas market.

Being one of the first generation of LNG plants, the power required for the precooling and liquefaction cycles and for electricity generation is delivered by means of HP steam turbines. The total HP steam consumption in the BLNG plant is some 1700 t/hr, produced by an infrastructure comprising of 9 fired boilers. The HP steam production is augmented by 10 waste heat boilers at a nearby power plant and at the onshore feedgas compression plant.

Together with a large raw water intake and treatment plant (more than 2000 t/hr), Nitrogen, instrument air and fuelgas systems, the BLNG plant has a very large Utilities component. This is typical for the first generation design concepts such as applied in the BLNG and MLNG Satu plants.

3. PLANT REJUVENATION AND ASSET REFERENCE PLAN

The 130 hectare BLNG complex and its 4 km long LNG ship loading jetty were designed to service the project's original 20-year supply commitment to Japan. Prior to the end of the first contract, a comprehensive rejuvenation of the plant costing more than B$500 million was carried out. This rejuvenation consisted of civil works including a new head office, insulation renewal, construction of a new LNG loading jetty and 2 new storage tanks. Also the old, analog control system was replaced by the latest digital plant control and automation system. This successful rejuvenation enabled BLNG to enter into another 20+year contract with its customers, including additional flexibility for increased volumes at periods of peak demand.

BLNG has now embarked on another extension and expansion phase, driven by the BLNG Asset Reference Plan, to pave the way for a third sales commitment and to stretch the lifetime of the plant to 2033. The ARP was kicked off with a study to first determine a clear position regarding the following key issues:

a) The technical risks involved with operating and maintaining rejuvenated facilities, covering the period until 2033,

b) To demonstrate that plant rejuvenation is clearly more cost-effective than replacing the existing facilities with (two) new liquefaction trains.

c) To make a qualitative assessment of the rejuvenated trains HSE performance against new-built units, applying modern international- and BLNG specific- HSE standards including sustainable development principles.

This high level review resulted in a positive decision regarding implementation of the ARP. No 'show stoppers' were identified that would make the rejuvenation option not viable or realistic.

Based on the current ARP scope, the expected impact on LNG production during implementation activities has been estimated at a total outage of two to three months per train, plus an additional 1-2 weeks for some complex plant/unit shutdowns dictated by projects in Utilities and Storage & Loading.

The main elements of the ARP are:

a) Main Cryogenic Heat Exchanger replacement. Four out of the five MCHEs will be replaced in 2004/2005. The new MCHEs are designed to equal the maximum capacity of the existing ones, plus a normal manufacturer´s design margin.

b) Cooling Water System upgrade. The available cooling water temperature and -flow play an important role in the performance of refrigerant cycles and must be adressed in the ARP. Recent trials have shown that for every deg. C colder CW supply, there is a 2% improvement in either energy use or production of LNG.

c) Replacement of the entire power generation plant by gas turbine generators (GTGs), and rejuvenation of the remaining steam boilers

d) Increase the Boil-Off Gas compressor capacity to eliminate storage tank boil-off gas venting during ship loading

e) Other environmental performance improvement projects, targetting air emissions and water outfall to sea

f) Replacement of specific field instrumentation, valves and electric motors

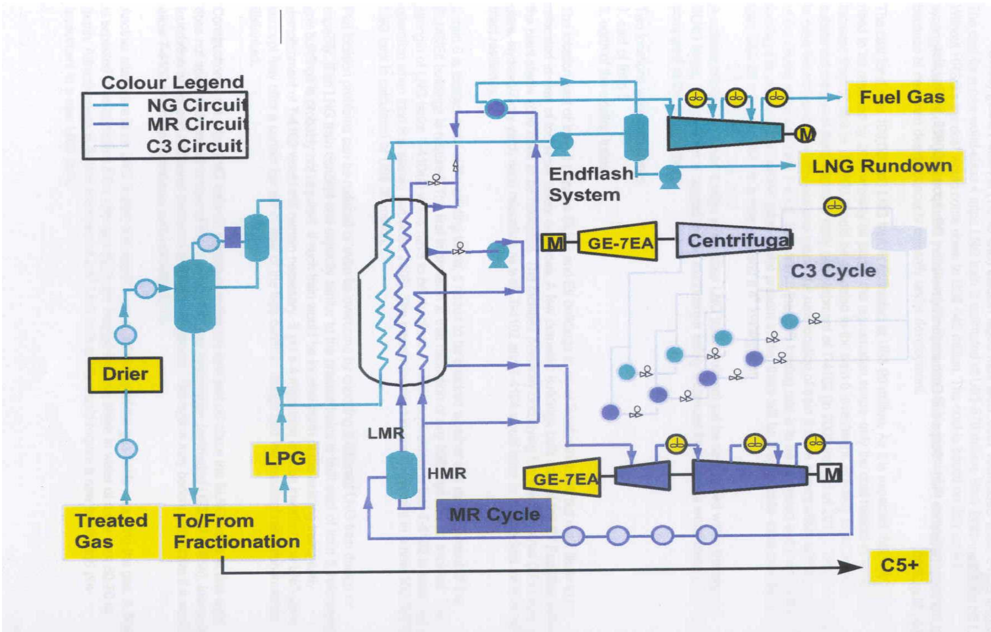
Apart from stretching the lifetime of the BLNG plant, the combined effect of the ARP improvements will result in a substantial increase in LNG production, typically from 205 to 215 B-cargoes per annum. Meanwhile BLNG has started with the implementation of Advanced Process Control, which will be the main vehicle to deliver this additional production potential on a sustainable basis.

4. SCENARIO FOR THE FUTURE: EXPANSION WITH A 6th LNG TRAIN

Although the ARP-based extension still is in various stages of design and engineering BLNG has already formulated a future expansion scenario for 2010 and beyond involving the construction of a 6th, world-class LNG train. It is evident that more than 4 tcf of new gas necessary to sustain a 20 year, 4 MMton/annum T6 production scenario must first be proven, and it is safe to predict that in the coming years all eyes will be on the exploration effort in the deep-water concession areas offshore Brunei.

5. PRELIMINARY SCOPE DEFINITION OF A NEW, 6th LNG TRAIN

In absence of reliable information on future feedgas supply and LNG market forecasts, the design concept and size of the world-class sixth LNG train will be assumed to be in line with the latest design concepts now being implemented, for instance for the MLNG Tiga project. To set the scene: a “world-class” LNG train has a capacity of some 4 MM ton per annum, is powered by two GE Frame 7 Gas Turbines or equivalent and is fully air-cooled.



Typical layout of 4 MMtpa LNG train

The actual scope of the 6th LNG train is preliminary defined to comprise the gas processing and liquefaction train, plus those utilities and common facilities which can not be supplied from existing facilities. On the upstream side, the slugcatcher and the gas metering station have been left out of this early scope since they would formally belong to the upstream gas suppliers and moreover no information is yet available on landed feedgas qualities. Similarly, no scope definition has yet been attempted for additional condensate processing facilities or possible commercial grade LPG extraction.

Even though this first scope of a 6th train project is far from complete, it is already a very useful concept to apply on the development of the various ARP projects which are now entering into the detailed engineering phase. Particularly to avoid regret ARP solutions in terms of plot plan changes and also regarding timing and scope of ARP projects in Storage and Loading and Utilities.

6. IIMPACT OF NEW TECHNOLOGY

The new technology features of a future T6 will have to be merged with the by then 40 years old existing BLNG plant. This will undoubtedly create some interesting design issues at the interface of the new T6 gas processing and liquefaction unit and the rest of the BLNG plant. A further complication will be that the Design & Engineering Standards for a baseload LNG plant have evolved considerably since the very early days when the original BLNG plant was designed. In the following paragraphs a number of these issues will be examined in more detail to determine the impact of the new technology which will be introduced with T6.

7. PROCESS INTEGRATION

Starting at the front-end of the future train 6, the acid gas removal unit will undoubtedly contain provisions to incinerate the CO2-rich offgas, especially if the new gas reserves for T6 turn out to be sour (containing H2S and Mercaptans). This modern environmental design standard must then also be evaluated as a possible retrofit for the existing five LNG trains. By contrast, the present feedgas is very sweet and in combination with recent improvements in the acid gas removal solvent being used any immediate investment in offgas incineration has a low priority on the Continuous Improvement agenda of BLNG's ISO14001-certified Environmental Management System

If the feedgas for T6 will be substantially higher in CO2 content than the present feedgas, then interconnectivity of feedgas supply between old and new plants will be restricted, and probably T1-5 will have to be debottlenecked to the same CO2 removal capacity. Interconnectivity of feedgas also becomes an issue when, for the purpose of higher liquefaction efficiency, the new LNG plant will be designed to operate at a higher operating pressure than T1-5.

The heavy hydrocarbon removal step and subsequent fractionation into refrigerant components and Condensate could be simplified when refrigerant for T6 could be fully taken from T1-5. In the context of the ARP, the present Refrigerant Manufacturing Units are receiving minor refurbishment only, and no immediate replacement of major process equipment like distillation columns or overhead condensers is planned. With the advent of T6 it will have to be considered to build a new in-train or standalone RMU on the T6 plot, especially if there is a business case to start extraction of commercial quantities of LPG's. Then only one of two existing RMU's need to be verified for full lifetime extension.

The T6 cryogenic process will have a much larger inventory of refrigerants than the present trains and due consideration must be given to recovering from a possible T6 process trip, after which a substantial amount of refrigerant may need to be replaced at short notice. Thus, the interconnectivity with the RMU's, supplemented by probably a doubling of refrigerant storage capacity will be critical to avoid production loss from slow refrigerant make-up to T6.

The T6 process design would probably include an end-flash unit to maximise production capacity. This will produce fuelgas as a by-product and the integration of this (large) fuelgas source with the existing fuel gas distribution system need to be carefully designed to ensure stable fuelgas quality particularly for the gas turbines during transient conditions.

7.1 Utilities Integration

The present LNG plant boasts a high thermal efficiency thanks to application of economisers and waste heat boilers. The two Fr7 gas turbines in T6 will be fitted out with similar waste heat boilers in their fluegas stacks, which would produce some 350 t/hr additional HP steam, enough to provide the total steam requirement for one of the existing trains. Sufficient fired boiler capacity must therefore be retained in the old plant to safeguard against any T6 outages. A full and complete rejuvenation of sufficient steam boiler capacity is therefore a key element in the present ARP campaign.

The replacement and extension of the present steam driven electrical generating capacity by gas turbine generators (GTGs) will be based on the expected maximum demand from the fully rejuvenated plant, which is currently projected to be some 50-53 MW as compared to 36 MW at present. No capacity will be included for the future T6, which will be self-contained regarding its power generation units. However, rejuvenation of high-voltage switchgear included in the ARP will include future interconnectivity with T6 as a non regret item.

Other Utility units are mostly modular and can be scaled up to meet T6 additional requirements. Particular attention will have to be paid to Instrument Air supply which will need to be expanded substantially to feed an additional air separation unit for the supply of Nitrogen to T6.

7.2 Storage and Loading Facilities

Major decisions regarding Storage and Loading will have to await the firming up of the Train 6 expansion project. In principle T6 will make use as much as possible of existing facilities of course, but some big ticket items are waiting in the wings.

For example, if the expanded BLNG operations require the LNG loading rate to be increased then an extra loading line will be required as a minimum, together with a 4th loading arm and possibly a second shipping berth. If this extra line can not be added to the existing trestle, then a complete new jetty will be required including a completely new loading system designed for a typical maximum loading rate of 10,000 m3/hr including Emergency Shut Down (ESD) and surge control protection. The ARP has identified the cold insulation of the present loading lines as a future (major-) maintenance item, and it is clear that this longer term issue would be optimally addressed in synergy with a future T6 project.

A similar big ticket item will be the addition of a 100,000 m3 LNG storage tank currently projected to be required for the T6 scenario. However, there is again a possible opportunity to optimise with the ARP, since one of the existing LNG tanks (T-4102) may be due for decommissioning in 2013.

8. COMMON SYSTEMS (FLARE, FIREWATER SYSTEMS, PLANT CONTROL AND AUTOMATION)

Another ARP project which will benefit from early consideration of the T6 expansion project is the Flare infrastructure. The existing flare stack structure is currently being assessed to determine its remaining lifetime and there is a real possibility that a major replacement project need to be carried out to secure the next 30-year operating period. In that case the latest flare system design will have to be adopted including segregation of “cold” and “warm” flaring. When T6 is included in a new, combined flare system design then a geat deal of detailed engineering will have to be performed for the T6 plant to determine the optimum flare infrastructure, including key issues such as the minimum (sloping-) flare header elevation. In the meantime the present flare system has been certified to meet the increased flare relief scenario´s from the MCHE replacement project and this provides a sound basis for scheduling any longer term ARP flare project in conjunction with the T6 design.

9. PLOT PLAN

A world-class, aircooled LNG train has a fairly large footprint and can be some 300 meter along its major axis, and its orientation will need to consider the prevailing wind direction(s) for optimum aircooler performance. Furthermore minimum safety distances need to be adhered to regarding sterile area requirement between the train and the outer fence as well as process safety considerations such as the location of fired heaters in relation to other process units.

Two potential plot locations have been tentatively identified, but both will require major changes to the present BLNG plotplan;

a) A T6 plot east of train 5 requires relocation of plant facilities for both BLNG and the adjacent TFE gas processing plant.

b) A T6 plot north of the existing trains requires LNG tank T-4102 to be demolished before the train 6 start-up, which requires pre-investment in a new and larger tank as well as relocation of the flare stack and its auxiliary equipment probably to a reclaimed area towards the sea.

Both locations have severe implications and further study into train concept/size and applicable safety distances to buildings are required to support a decision on preferred plot location.

An additional possibility would be move further North and reclaim land along the existing jetty. Whilst this would solve most other plot plan issues it carries a substantial cost of some 30 MM B$ for land reclamation, plus additional cost for additional foundation works and corrosion protection.

10. CONCLUSION

In this paper an overview is given of the dynamic transition processes which are at work at BLNG. After more than 30 years of setting the standards in the emerging LNG Industry as a most reliable, customer-oriented supplier in the Asia-Pacific region, BLNG is now actively actively pursuing and fully committed to a second and even stronger 30-year operating period. The short term agenda has already moved into high gear via the Asset Reference Plan campaign whilst a longer term expansion scenario with a new world-class 6^{th} train is waiting in the wings. Technical challenges related to a future integration of the train 6 new technology with the existing plant have been identified and provide guidance for decisions on ongoing rejuvenation activities.