AMPA FAIRLEY RATIONALISATION PROJECT

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INTRODUCTION

Brunei Shell Petroleum has been the supplier of over 90% of the feedstock for the Brunei LNG project, the first Asia Pacific LNG scheme, for the last 30 years. It has combined high reliability of supply with effective replacement of reserves, such that BSP's gas reserves are higher in 2002 than they were twenty years ago.

The LNG project was initially based on HHP gas, largely from the South West Ampa Field. Over time the profile of production has changed, with an increasing diversity of gas sources, and rising compression requirements.

With the reserves to support at least a further 30 years of LNG production, a comprehensive project is being executed to expand and upgrade BSP's gas infrastructure, including new export pipelines, the replacement of 17 Offshore compressors with an Onshore Compression Plant, the installation of new control rooms and significant process simplification through the adoption of wet gas export.

Furthermore, this substantial investment for the future is being executed at a time when BLNG's exports are at historical high levels.

In addition to the technical and economic benefits, the project will enhance safety and substantially reduce the Global Warming Potential of BSP's operations.

This paper aims at introducing Brunei Shell Petroleum Company in general and highlighting at a very high level the Ampa Fairley Rationalization Project, the reason why the project was required and the execution side of it.

BRUNEI SHELL PETROLEUM SDN BHD.

Brunei Shell Petroleum (BSP), a 50/50 joint venture between Royal Dutch/Shell and the Government of Brunei, has been operating in Brunei Darussalam for over 70 years, with activities primarily in exploring for and producing of oil and natural gas. Initially, BSP's focus was only on oil production and export but later added gas gathering facilities for gas export to the BLNG (Brunei Liquefied Natural Gas) Plant. Gas is exported to BLNG at HHP (High High Pressure of around 56 Bar).

BSP's oil production peaked in the late 70's at over 240,000 barrel per day but in 1981, the Brunei Government deliberately imposed limits on production to extend reserves and to improve recovery. BSP's average production level in 2002 for oil was 200,000 barrels per day. ASEAN countries took more than a third of the total export of Brunei Darussalam crude, followed by Japan, Korea and USA as major purchasers. Smaller sales are made to Australia, New Zealand, China and India.

Since the start of BLNG operation in 1972 until the year 1999, BSP had been the only supplier of gas to BLNG. When another gas producing consortium started exporting its production to BLNG in 1999, BSP maintained its role as the main gas supplier, reliably delivering over 90% of the intake to BLNG. In 2002, BSP's average gas export to BLNG was 28.8 million sm3/d. So far, BLNG has had an enviable record in fulfilling its commitment of LNG delivery to its customers which mainly are from

Japan and Korea. They have managed supply more than 4000 LNG cargoes and last year BLNG achieved their highest number ever of LNG cargoes exported. This year, they have made a commitment of even higher number of cargoes. This shows the high confidence placed on BSP to meet their demand. It is BSP's aspiration to continue maintain its reliability as the major supplier to BLNG and the demands of their customers.

BSP produces its oil and gas from three areas: the offshore West, offshore East and Onshore. Offshore East which mainly comprises the Champion Field with some smaller fields such as Iron Duke, Champion West, Magpie and Peragam, produces the majority of BSP's oil with the gas being primarily used to supply fuel gas for BSP own and BLNG use, and Brunei Government power generation requirements with the remaining majority being fed to BLNG. The Champion Field alone contains about 40% of the total Brunei oil reserves. The Onshore area which mainly comprises the Seria Field, has been operating since 1929 when the first commercial oil discovery in Brunei was made. Production peaked at 100,000 barrel per day in the 1950s and in year 1991, the Seria Field celebrated its one billion barrel of production. Currently, the Field is still healthily producing around 26,000 barrels per day of oil. The offshore West, the oldest offshore producing area, is currently BSP's main gas producer, accounting for more than 75% of the total BSP gas exported to BLNG and contains half of the BSP's gas reserves. Some one third of BSP produced oil also comes from this area.

Future exploration activities are focusing on identifying and assessing the ultimate oil and gas reserves of its extensive concessions while development will seek to maintain production levels. Aggressive conversion of scope for recovery and an attractive exploration portfolio is expected to contribute significantly more reserves to BSP.

In carrying out its activities, BSP is fully and strongly committed to environmental protection and improvement and constantly strives to minimize impact of their activities on the environment. BSP has set stringent environmental standards and practices as a contribution to the sustainable development of Brunei Darussalam in the aspect of environmental preservation. This includes commitment to eliminate continuous gas disposal by venting and flaring by years 2003 and 2008 respectively and gas disposal by venting or flaring has been excluded in new project design.

As Brunei's economy is dominated by the hydrocarbon sector which accounts for more than 50% of the GDP and more than 90% of Brunei total export earnings, BSP is expected to continue playing an important role in Brunei's development in the coming foreseeable future, despite the rapidly progress on efforts to diversify the economy from this non-renewable resource.

All above are in-line with the BSP's mission " to find, produce and sell hydrocarbon in a responsible way while achieving sustainable growth in the business, generating increasing returns to the Brunei government and shareholders, in harmony with the aspirations of the Nation"

AMPA AND FAIRLEY FIELD INFRASTRUCTURE

The offshore West is located some 15 to 40 km from the coastline of Brunei in water depths up to about 60m. There are two main fields in the offshore West, the Ampa Field which is located about 15 km from shore and the Fairley Field, situated a bit further offshore some 40km away from shore. There are also other small producing fields and a few undeveloped fields within the area. The gas production from this area consists of both non-associated and associated gas.

The Ampa field was the first Brunei's producing offshore field, discovered in 1963 with production starting in 1965. The field is large, mature and complex containing more than 400 oil rim reservoirs and 380 non-associated gas reservoirs, out of which, only 11 reservoirs contain in excess of 5 E6 m3 of oil.

The field saw extensive surface facilities development in the '70's. Before the implementation of the rationalized concept, the produced oil was stabilized at 7 outlying production platforms before being pumped to the onshore terminal for dehydration and export. The separated gas is gathered on two manned complexes, Ampa-6 and Ampa-9, where gas processing and compression take place. Currently, the field is producing around 50,000 barrel per day oil and around 22 million sm3/d gas.

The nearby Fairley Field was discovered in 1969 and started production in year 1984. It is a topographically scattered collection of 9 major fault blocks and structural culminations. Currently, the field is being serviced by 4 outlying production platforms for oil stabilization and one manned complex, Fairley-4, for gas processing and compression. Current daily production from this field averages 18,000 barrel per day oil and 3-4 million sm3/d gas.

To date more than 100 offshore platforms and 220 pipelines have been installed within these two fields. Most of these platforms are integrated to each other as such that losing one platform can cause shutdown of the others.

HHP gas is mainly exported to BLNG as feedstock. Compression is required to bring oil associated gas which is mainly produced at LP (low pressure - 4 bar) and limited amount of non-associated gas which is produced at HP (high pressure -18 Bar) to (HHP) export pressure for delivery to BLNG. Non-associated HHP gas is exported without the need for compression. To date, there are a total of 29 compression trains located at these three complexes, 13 on Ampa-9 and 8 each on Ampa-6 and Fairley-4 with a total compression capacity of 13 million sm3/d.

The gas used to undergo dehydration at the main complexes before leaving for export to BLNG through two 28" trunklines but is now exported wet as part of the change resulting from this project. The oil and condensate is exported to Seria terminal for further stabilization, dehydration and export.

BUSINESS DRIVERS FOR CHANGE

Sub-surface development studies have confirmed that hydrocarbon in both developed and undeveloped reserves around the Ampa and Fairley areas is significant, with 72 E m3 liquid reserve and 244 E9 m3 gas reserves. In addition, there are also significant scope for recovery volumes in both discovered fields and exploration prospects. It total, the area would likely sustain at least another 30 to 40 years of oil and gas production. In fact, over 50% of the BSP gas reserves are situated in the Ampa Field alone. Therefore, the area has a key role to play in setting and achieving the BSP's long term strategic aims in expanding gas production to optimize usage of the BLNG plant and maintaining oil production at a level above 150,000 bbl/d.

Even though development of these reserves is considered robust against an oil price of US$14 per barrel, it is heavily reliant on the set up of the Ampa and Fairley infrastructure.

The existing production infrastructure is extensive and, by most yardsticks, very complex but does not give a lot of flexibility for future development. There are a number of critical facilities which have been operating for more than 25 years, beyond their designed life of 20 years. The ageing facilities also pose hazards and risks not only to the asset itself but also to the operators.

There is a tendency for upward operating expenditure as integrity issues feature more prominently in future years. Reliability and availability of the facilities are also deteriorating, impacting on the ability to sustain continuous production. The locations of the outlying platforms also require complicated logistics.

With the declining field reservoir pressure and increasing gas to oil ratio, more and more production will rely heavily on compression if production rates are to be maintained from this area and ultimate recovery maximized. It is expected that the Ampa area will be short of gas compression capacity if the no project were executed to boost the existing capacity.

Moreover, most of the compressors on Ampa-6 and Ampa-9 have been operating close to 30 years where as the design life of all these machines are for 25 years. The Fairley-4 compressors are reaching a service life of 20 years. Although the modules currently still achieve the efficiency, availability and reliability levels required, this is only possible by employing a dedicated compressor maintenance crew and continuous maintenance activities. There is no credible assurance that the

modules can be kept running for another 30 years. Even if they can, the operating cost would be unbearably high.

There is an increasing push to continue operation whilst meeting the stiffer environmental requirement. The majority of the Ampa and Fairley infrastructure was installed more than 20 years ago and compliance with HSE latest standards was always problematic. Before BSP embarked on this project to reduce venting, Offshore West vented an estimated 350,000 m3/d of hydrocarbon mainly from crude stabilization processes and another 100,000 sm3/d from trips/blowdown especially due to the ageing compressors.

The crude export facilities which are being modified under this project, also featured a total of 23 gas reciprocating expansion motor driven pumps, utilizing some 500,000 sm3/d of high pressure gas as motive energy whilst the low pressure gas exhaust is recovered for compression back to high pressure. This process not only fills up the compression ullage but it is really an inefficient use of power through burning of fuel gas to run the compressor. Gas leaks from pump glands was very susceptible which released gas to atmosphere.

Based on QRA (Quantitative Risk Analysis) studies on the three manned complexes in support of the safety cases, it was found that the maximum individual risk level and total PLL (potential for loss of life) on two of the manned complexes fall into the intolerable band. The Fairley-4 Living Quarters module, being situated very close to the gas-processing platforms, had the highest risks. A number of remedial actions have been implemented and significant risk reduction has been realized and the overall risks will be brought down to tolerable levels with the implementation of this project which includes the installation of new living quarters for the FA-4 complex.

Infrastructure studies have shown that major investment are required to tackle the above issues to support safe and reliable production of the Ampa and Fairley Field over the long term.

STUDY

During 1995/1996 as part of the overall objective to rejuvenate the ageing and, in some case, obsolete facilities, BSP embarked on an extensive study involving various disciplines within BSP and BLNG to investigate various strategies to determine the optimum infrastructure for operating the Ampa and Fairley Fields in the long term, taking into account all the pertaining issues with relation to the developed and undeveloped reserves, scope for recovery and exploration opportunities, infrastructure for development, environmental, safety legacies and operational expenditure. In general the study covered the following challenges;

- How to meet the increasing demand of gas compression in the next 30-40 years, given that the compressors installed in the 70's are already operating beyond their original design life. This is reflected in a trend of increasing compressors trips and breakdown.

- How to counter a trend of increasing unit operating costs, due to ageing facilities and declining oil production

- How to reduce both personnel and asset integrity risks with respect to the legacy infrastructure and ageing facilities

- How to ensure that the facilities meet the latest HSE standards with respect to stiffer environmental targets.

- How to maximize flexibility for further development, making use of the existing infrastructure, i.e. without installing new platforms.

Given the area's current issues and future business objectives, possible infrastructure strategies fall broadly into one of the following three categories

- Continue with the current infrastructure, replace if necessary like for like but execute the necessary projects to meet production, safety and environmental objectives. This strategy is called “As Is”.
- Continue with the current infrastructure but completely refurbish the many production critical facilities such as compression and crude exports. In addition execute the necessary project to meet production safety and environmental objectives. This strategy is known as ”Refurbishment”.

- Rationalize and simplify the current infrastructure and at the same time execute necessary project to meet production safety and environmental objectives - a strategy known as “Rationalisation”.

All three strategies were evaluated thoroughly in terms of tangible advantages and disadvantages, which then, as far as possible, were translated to Net Present Value. Some other more difficult to quantify factors such as field life, flexibility for future development, operability were also taken into account.

In the end, the study concluded that Rationalisation, which involves a radical change and simplification of the modus operandi of the existing fields, was the most attractive compared to the other strategies. An integrated project known as the Ampa/Fairley Rationalisation Project emerged.

PROJECT SCOPE

The scope of the Ampa/Fairley Rationalisation Project comprises;

- Replacing the 17 offshore HP compression modules on three complexes with 3 larger onshore based compression trains next to BLNG plant including waste heat recovery boilers for the BLNG plan.

- To allow HP gas export to shore, a new 33km 40” HP gas export pipeline, the largest in Brunei, was installed between Ampa-6 and BLNG together with a slugcatcher at the end of the pipeline as well as downgrading few of the HHP export pipelines to HP gas export.

- Replacing the 8 LP compression modules on Ampa-6 and Ampa-9 with 2 larger modules centrally located on Ampa-9. This also includes the installation of 6km 28” LP pipeline to allow export of the Ampa-6 LP gas production to Ampa-9.

- Rewheeling of existing HP compression modules on Fairley-4 to operate at lower suction pressure.

- Simplification of offshore facilities by centralizing the crude stabilization and export to 3 central locations instead of the 11 outlying production platforms. A number of pipelines were requiring service change to allow multiphase flow to the central facilities.

- Converting the disposal of the remaining gas from venting to flaring (which greatly reduces the impact on the environment).

- Remote control of the Ampa-6 complex from Ampa-9 to allow demanning of this complex

- Refurbishment/replacement/removal of Ampa-9, Fairley-4 and Ampa-6 living quarters respectively.

- Conversion of dehydrated gas export to wet gas export with the pipeline being protected by injection of corrosion inhibitor thus eliminating the need for the complex offshore glycol dehydration system located on the three complexes.

INNOVATIVE SOLUTIONS

The Rationalisation strategy was not the cheapest option of the three considered on a capital expenditure basis but was selected based on the maximum tangible and intangible advantages it presented over the other strategies over the lifetime of the Ampa and Fairley fields. The overall Net Present Value of the Rationalization strategy is substantially more than the other strategies in which the early lower capital investment was eventually offset by substantially higher OPEX levels in longer term and also higher expenditure required to implement the necessary projects to meet new developments, production, safety and environmental objectives.

The replacement of the 17 HP compressors offshore with 3 large onshore based machines would allow the decommissioning and removal of the offshore compressors and create space for new facilities to be installed without requiring new major infrastructures which otherwise would result in higher expenditures. On Ampa-9, the created space would be used for the installation of the two new LP compressors whilst on Ampa-6, a new flare system 40” pipeline and pigging facilities would be installed. A new CCS (Centralized Crude Stabilization) module and also a new flare system would be installed in the space created after the removal of three out of the six existing Fairley-4 compressors.

The removed Fairley-4 compressors would be relocated onshore and would be used to boost the onshore compression capacity for the gas production of the Onshore Field without any need for procuring new compressors. Similarly, rewheeling the remaining HP compressors on Fairley-4 would increase the LP compression capacity at the lowest possible cost.

The elimination of the HP compression system on Fairley-4 would lead to a reduction of the risks to a sufficiently low level to the personnel living in the nearby living quarters so that relocation to a new location, which would have required major infrastructure, could be avoided.

The centralizing of the LP facilities on Ampa-9 complex would allow removal of the LP compression modules on Ampa-6. With new DCS/IPS control systems to allow control of this complex from Ampa-9 and the decommissioning of HP compression facilities, the operation of the Ampa-6 complex would become simplified and could be demanned permanently. This should remove the requirement to implement any remediation of the Ampa-6 living quarters identified by the safety case study.

Quite a number of the existing pipelines would change services from High Pressure (HP) to Low Pressure (LP) operation to meet the crude stabilization and HP compression relocation. This would extend the operating life of these pipelines removing the need for replacement.

The centralizing of crude stabilization from 11 outlying production platforms to only 3 central facilities would allow the usually vented gas to be gathered, recovered or flared centrally in the most economic way. This also would allow removal of the existing gas driven crude transfer pumps thus releasing the load on the compressors and significant saving on fuel gas. With fewer centralized facilities, logistics would become simpler and this would reduce the risk level of the operator who had normally to travel a lot in the non-rationalised set-up.

The conversion of dry gas export to wet gas export would allow decommissioning of the six ageing and complex offshore glycol dehydration trains and thus remove the hazardous gas (benzene, toluene and xylene) emitted from this process. Protection of the main export pipelines would be taken care of by a far simpler solution corrosion inhibition injection into the export pipelines.

The simplification of offshore facilities is expected to reduce the operating costs by around US$8.0 million per annum thus allowing the fields to be operated more cheaply and therefore extend the field economic production life.

The risks such as production deferment posed by execution activities can also be reduced to a minimum as the old facilities can be left operating normally while commissioning of the new facilities is ongoing. The old facilities will only be switched off once the new facilities have been successfully commissioned and operated for a period to give confidence in stable operations.

The new onshore HP compression plant, which is designed to cater for future production from Ampa and Fairley and currently being commissioned, yields further opportunities for other operating areas of BSP. As of now, the Offshore East takes advantage of this by exporting HP gas to shore thus avoiding the need for new offshore compression facilities in Offshore East which of course would require higher expenditure than a centralized onshore plant.

The waste heat generated by the gas turbines which drive the compressors is also used to generate steam for BLNG thus making it possible to decommission some of the ageing BLNG steam boilers and also save fuel gas which is equivalent of some 3 LNG cargoes of gas per year.

The introduction of HP export mode on top of the current and only HHP mode gives additional flexibility to the gas export system and improves overall system reliability.

All these advantages cannot be provided by the other strategies and thus make the rationalization concept the most innovative and economic way of tackling the many issues facing by the Ampa and Fairley Fields.

EXECUTION

The Ampa Fairley Rationalisation Project was officially launched in May 2000 by the Brunei's Minister of Industry and Primary Resources who was also the Chairman of the Board of Directors of Brunei Shell Petroleum. With a total project cost of more than US$360 million and involving major modifications to the existing facilities, it is the most complex and one of the largest projects ever to be undertaken by Brunei Shell Petroleum.

In fact, the launching ceremony did not come that easy. Before that ceremony, the project had to undergo comprehensive reviews and audits both internally and externally right from the identification stages all the way to finalization the concept and budget submission. This probably the first and only BSP's project which undergone a complete review cycles as stipulated in the shell Project Management Guides. Extensive and continuous engagements with stakeholders especially government agencies were held to convey the project benefits and get their full support for the execution. Setting up a dedicated project team from nobody also faced difficulties as it involved quite a number of movements of BSP's staff and recruitments of new staff both locally and abroad. Various workshops were conducted to come up with the best project execution and contracting strategies. Few new management systems were introduced and put in place to cater for the many project issues and aspects. Project costs estimate undergone continuous screening until budget submission and approval in 1999. In the same year, a number of major contracts were awarded with strong emphasis on Brunei's local contractors.

The project execution schedule is partly determined by the corporate environmental target of no venting by year 2003. New field development and BLNG gas demand also influence the schedule to an extent

The greatest challenge for the project is to carry out all this work with minimum disruption to the oil and gas production. Such a drastic change to the existing infrastructure and facilities requires detailed project execution planning, especially when the execution takes place at a time when BLNG's export is at historically high levels. Adequate contingencies are provided to allow for dual mode of operation of old and new facilities during the transition phase to minimize deferment in case the new facilities face problems during starting up and the initial operating period.

For proper management and smooth running of the project, the project is broken down to a number of phases, sub-projects and sequences. Phase 1 covers activities to relocate the HP gas compression from offshore to onshore. This includes the installation and commissioning of the new onshore compression plant. This phase is further split into three sub-projects to reflect the different locations and different scopes of work. The three sub-projects are the onshore compression plant, the new pipelines and the offshore modifications. One of the sequences covers the provision to enable switching the old facilities back in case the new facilities encounter problems during commissioning.

Phase 2 will be to centralize the LP compression facilities to Ampa-9. and to provide new Living Quarters on Fairley-4 and to refurbish the existing Living Quarters on Ampa-9

The project has a very comprehensive review and audit programme to provide assurance that the best technical and commercial strategies are put in place and that the execution is managed in accordance with BSP's ISO 9000 accredited Management System.

A number of new project controls were introduced. The Risk, Uncertainties and Constraint (RUC) Management System identifies and quantifies the risks and constraints in advance and put controls in place to mitigate their impact and identify contingency measures. The Stakeholder Management system also works the same way but identifies stakeholder issues and the management to efficiently address them with the various internal and external stakeholders. To allow proper addressing of the many interfaces the project has both internally and externally, an Interface Management System has been introduced which identifies clearly the boundaries between interfaces and the responsible parties. An Engineering Information Management System, the first in Brunei with an internet-based system, allows near instantaneous transfer of electronic documentation between the many project offices and contractors across national boundaries and this manages the work flow between the various parties.

There are also innovations in the contracting strategy. The contract for the engineering and construction of the onshore compression facilities was tendered through an international design competition, the first in BSP. This had led to a well-designed plant with the contractor being responsible to meet the performance specifications, including a two-year period post-commissioning.

Other innovative contracting strategies include the award of the Main Instrument Vendor (MIV) contract to a single contractor who is responsible for the engineering, system integration, procurement, testing and commissioning of all the many new instrumentation and control equipment and systems for all the different sub-projects. The strategy ensures the consistency of new equipment standards and is expected to result in many benefits in the long term. Procurement of the pipelines using Shell Group leverage is another innovative approach and also helped in reducing the cost for the pipeline materials.

New and latest technologies have also been incorporated in the project. The latest state of art DCS/ IPS/FGS instrumentation and control systems were introduced, replacing the ageing pneumatic instrumentation system. This not only improves the reliability of the instrumentation but also allows the future demanned Ampa-6 complex to be controlled remotely from the Ampa-9 complex, greatly reducing the operating costs. Field Signature Method (FSM) monitoring tools which measure corrosion rates of submarine pipelines in real time were also installed in two of the main gas export pipelines.

The use of automatic welding machine and automated ultrasonic inspection techniques, the first in the Brunei, together with quick-curing polyurethane foam for in-fill joint coating, improved barge lay rate for the 40" pipeline to an average of 2 km per day with only 0.28% repair rate compared to an average of 1 km per day and 3% repair rate using conventional welding and inspection techniques. This was a BSP's record for large pipeline lay rate.

The majority of BSP and BLNG staff working on this project are Bruneians. This is an indication of the successful development of citizens and the high degree of technical competence of Bruneians. A large part of the work is also being carried out by Bruneian contractors which demonstrates the maturing capabilities of local contractors in carrying out highly technical and complex jobs.

The project saw heavy activities offshore in year 2001 when the Ampa-6 and Ampa-9 complexes and their outlaying outstations undergone major modifications. The change over from obsolete relay based instrumentation system to state-of art distributed control system (DCS) and instrument protection system were successfully implemented at negligible disruption to oil and gas supply. Centralizing the crude stabilization facilities were also completed on the Ampa-6 and Ampa-9 complexes. The laying of the two new pipelines was also completed in that year with a number of records.

To date, Phase 1 is nearing completion with the commissioning of the onshore compression plant ongoing and Phase 2 is progressing well for the new LP compression modules currently under

construction in Italy. This year will see major modifications on FA-4 complexes and the installation of the new LP compression modules on Ampa-9. The remaining jobs for next year will be the removal of the redundant facilities.

The task ahead is to realize the benefits the projects promise to the Ampa and Fairley Fields by providing security to the gas supply chain to BLNG in a world-class HSE environment.

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