THE DARWIN LNG PROJECT

LE PROJET DE GNL DE DARWIN

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ABSTRACT

With the start of construction on the Darwin LNG Project in June 2003, ConocoPhillips will set a new benchmark for LNG projects by using aero-derivative gas turbines as drivers for the LNG refrigeration train.

Thirty-five years ago, in 1969, the ConocoPhillips-designed Kenai LNG Plant in Alaska delivered the first commercial LNG exported from the Western Hemisphere to Japan's Tokyo Electric Power Company, Inc. (Tokyo Electric) and Tokyo Gas Co., Ltd. (Tokyo Gas). This LNG operation pioneered the LNG trade to the Pacific Rim, which has grown from less than 1 MTPA in 1969 to more than 80 MTPA today. The Darwin LNG Project continues this long-term relationship between ConocoPhillips, Tokyo Electric, and Tokyo Gas with the development of a single train grassroots LNG Plant in Darwin, Australia. This will also be the first LNG project where Tokyo Electric and Tokyo Gas are not just the buyers for the LNG, but also equity owners in the related upstream gas condensate and LPG reserves, pipeline, and associated LNG plant, an indication of the commitment toward a continued long-term relationship amongst the three companies.

The Darwin LNG Project will also introduce several new firsts in the evolution of LNG liquefaction technology. Again, thirty-five years ago, the Kenai LNG Project set the future trend for the LNG industry by becoming the first to use gas versus steam turbines for refrigerant compressor drivers. The Darwin LNG Project will continue to build on this history of innovation and evolution of the LNG industry by being the first LNG plant to use high efficiency, low emissions aero-derivative designed gas turbines for refrigerant drivers. The LNG Plant will also incorporate several other design features to reduce greenhouse gas emissions.

This paper will discuss the history of the commercial development of the Darwin LNG Project that resulted in the execution of a binding HOA and gas field equity ownership with Tokyo Electric and Tokyo Gas. The various design innovations that will be incorporated into the LNG Plant to reduce greenhouse gas emissions will also be discussed. The paper will provide an overview of the project development activities, including initial contract development, current project schedule, workforce management issues, and the plant handover process.

INTRODUCTION

In 1995, the Bayu-Undan Field was discovered by ConocoPhillips approximately 500 kilometers northwest of Darwin, Australia in the Timor Sea. (See Figure 1). Delineation drilling over the next two years determined the Bayu-Undan Field to be of world-class quality with expected reserves of 3.4 TCF gas and 400 MMbbls of condensate and LPG's. Since 1995 ConocoPhillips has been aggressively pursuing options to monetize the 3.4 TCF of gas from this field. This effort has culminated in the commercial development of the Darwin LNG Project through the execution of a binding HOA and gas field equity ownership with Tokyo Electric and Tokyo Gas.

The Darwin LNG Project will consist of the construction of a nominal 3 million tonnes per annum (MTPA) LNG plant at Wickham Point, located in Darwin Harbour, and a 500-km, 26" subsea pipeline that will connect the LNG Plant to the Bayu-Undan offshore facilities. Construction of the LNG Plant and manufacture of the line pipe began in 2003. Site preparation at Wickham Point commenced in June 2003 and the project is proceeding on schedule with first LNG delivery scheduled for early 2006.

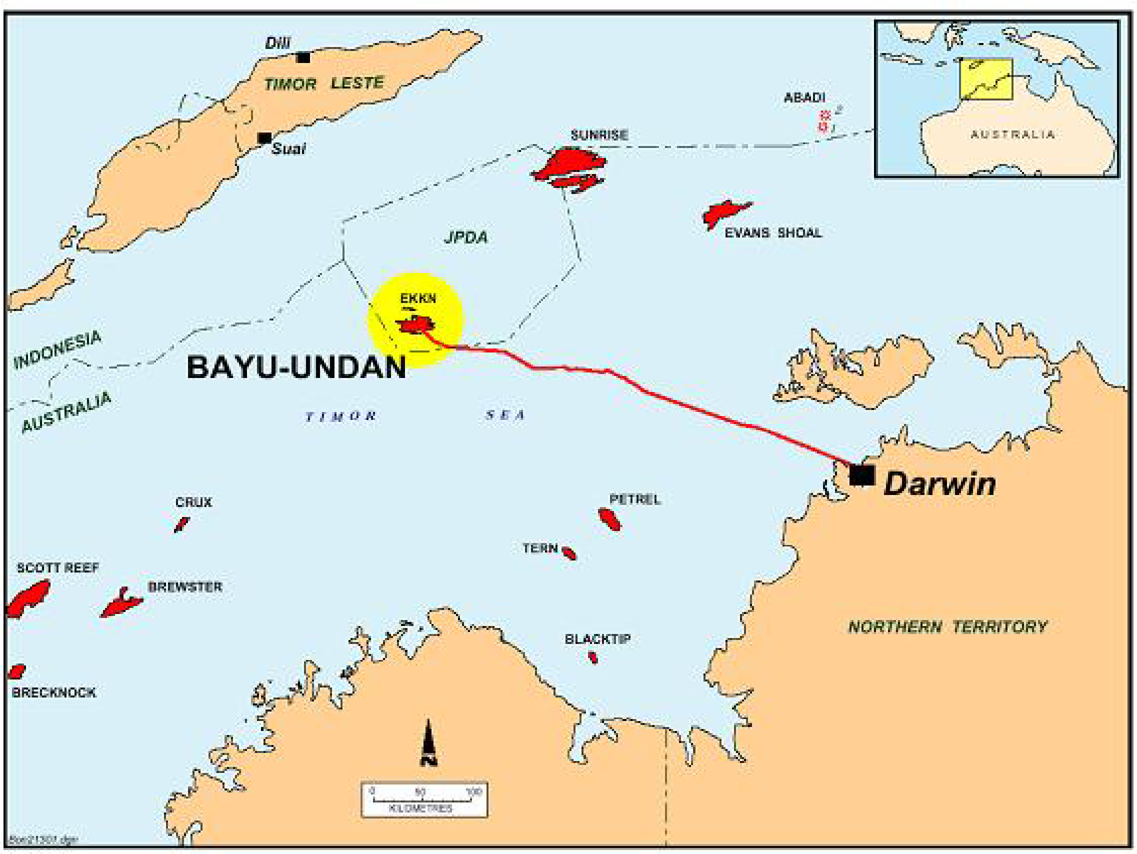

Figure 1 Bayu-Undan Field Location

EARLY PROJECT DEVELOPMENT

Upon the discovery of the Bayu-Undan Field in 1995, ConocoPhillips initiated studies for development of an onshore LNG Plant. Initial efforts focused on site selection and economic comparisons on the various onshore and offshore gas/condensate processing options that were available. Two main gas/condensate processing schemes were being considered by ConocoPhillips at that time. These consisted of maximizing condensate and LPG removal offshore with a lean hydrocarbon gas stream sent onshore to the LNG Plant and the other consisted of minimizing the amount of gas processing offshore and thereby maximizing the amount of condensate and LPG-bearing gas products to be sent to the onshore LNG Plant.

The site selection efforts concluded that Wickham Point, located in Darwin harbour, was the preferred location for the onshore facility and ConocoPhillips proceeded with the environmental approval process for a proposal to construct a 3 MTPA LNG Plant at Wickham Point in Darwin, linked by a subsea pipeline from the Bayu-Undan Field. In March of 1998 ConocoPhillips received the required environmental approvals for construction of this facility.

Shortly after environmental approvals were issued for the 3 MTPA plant, the LNG market underwent a dramatic downturn principally as a result of weakening economic conditions in the principal LNG receiving nations in Asia. ConocoPhillips suspended engineering work on the LNG project and focused its efforts on developing an offshore development for the Bayu-Undan Field that pursued maximum recovery of liquid products offshore with re-injection of the remaining stripped gas into the reservoir. During the follow-on period, ConocoPhillips concentrated natural gas marketing efforts on domestic opportunities but also continued to seek LNG customers for a Darwin plant.

In mid-1999 ConocoPhillips increased its shareholder position in the Bayu-Undan Field by acquiring the assets of BHP to become the majority shareholder and Operator of the associated units. Consequently, ConocoPhillips proceeded to amend its approved 3 MTPA LNG permit as noted herein, and to secure environmental approvals for a larger 10 LNG MTPA facility.

LNG MARKET DEVELOPMENT

In the latter part of 1999, after ConocoPhillips increased its shareholder position in the Bayu-Undan Field, a concerted LNG marketing effort was commenced. Relatively early in this marketing process, long-term Alaska LNG customers Tokyo Electric and Tokyo Gas emerged as highly favored customers for Darwin LNG. Over a two-year period of dedicated discussions, agreements between Tokyo Electric, Tokyo Gas and ConocoPhillips ultimately progressed to a binding LNG Sales Heads of Agreement

(HOA) for 3 MTPA LNG sales (F.O.B.) with first deliveries commencing early 2006. Concurrently, a series of agreements were similarly executed whereby Tokyo Electric and Tokyo Gas would acquire participating interests in the upstream assets associated with Darwin LNG including an interest in the Bayu-Undan Field itself as well as the associated gas pipeline and onshore LNG Plant.

Whereas a typical gestation period (from discovery to first LNG deliveries) for a greenfield LNG project might easily average 20 years or longer, there were some crucial factors which were key to the timely success of Darwin LNG:

- LNG projects are long and expensive ventures requiring huge investments by both the LNG sellers and LNG buyers. The dependability and reliability of these assets is as important as the cooperation of the LNG buyers and sellers themselves. The importance of the relationships and spirit of cooperation developed and cultivated between Tokyo Electric, Tokyo Gas and ConocoPhillips over the 30+ history of the Alaska project in facilitating Darwin LNG cannot be overestimated. In fact, this 30+ year history of cooperation was instrumental to the success of Darwin LNG.
- While the benefits of economy-of-scale are undeniable, there are also merits associated with a project of a more manageable size – in this case a nominal 3 MTPA train:
    - Aggregation of required market volume to achieve the “critical mass” necessary to launch the project is somewhat less problematic.
    - Coordination of issues between various buyers and meeting those buyers’ individual needs are less complex when the number of buyers is 2 or 3 vs. 5 or 6.
- ConocoPhillips’ track record in designing, building and operating highly reliable and flexible single liquefaction trains utilizing the Phillips Optimized Cascade Process.
- The LNG development was based on a proven onshore LNG plant application and design.
- A “built-for-purpose” LNG Plant and ancillary facilities design philosophy in order to achieve a most competitive cost structure without sacrificing reliability or expandability.
- Coventurers who are of similar mind and values and a project structure that provides alignment.

PLANT DESIGN

The Darwin LNG Plant will use the Phillips Optimized Cascade LNG Process as the basis for its LNG liquefaction technology. This technology was first used in ConocoPhillips’ Kenai LNG Plant in Alaska and more recently at the Atlantic LNG facility in Trinidad. The first train at Atlantic commenced LNG production in May of 1999 and the facility completed the start up of its third train in June 2003. Train four, with a design capacity approaching 5 MTPA, is currently under construction. The Phillips

Optimized Cascade LNG Process was also chosen for the two trains of the Egyptian LNG project and the first of these is scheduled to start LNG production in 2005, ahead of the Darwin LNG project. Figure 2 below shows a simplified process flow diagram of the LNG Process.

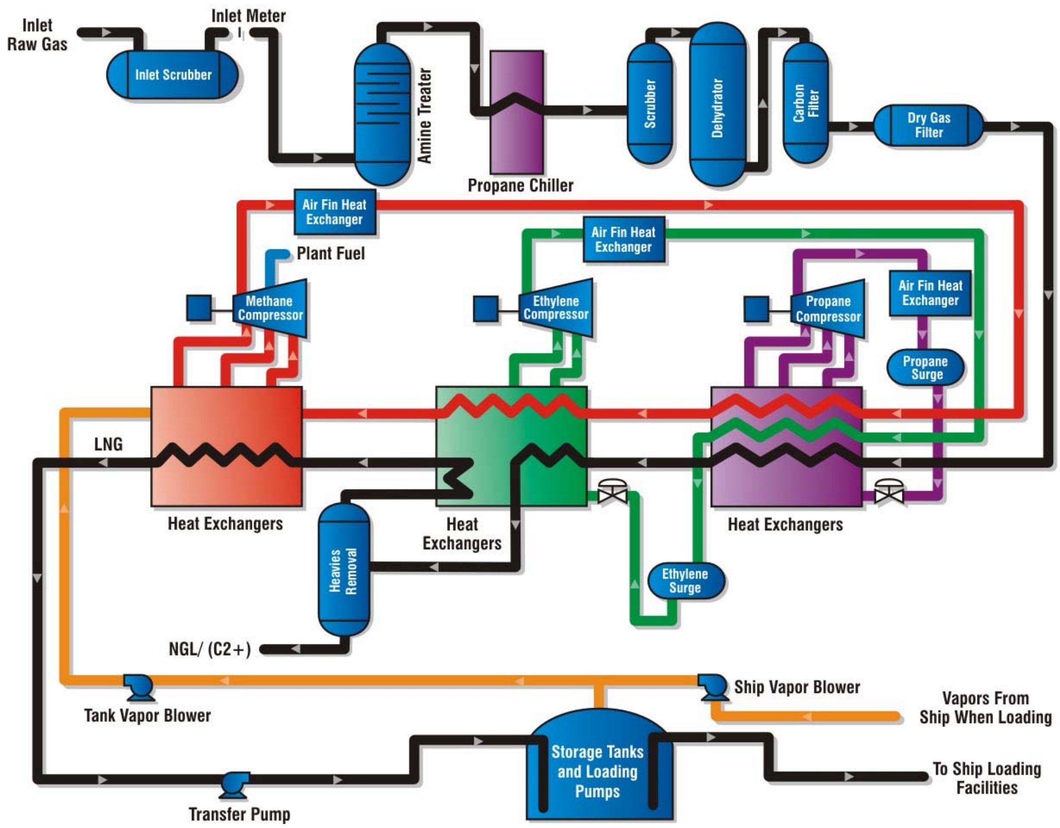

Figure 2 Phillips Optimized Cascade LNG Process

The Darwin LNG Project will also introduce several firsts in the evolution of LNG liquefaction technology. Thirty-five years ago the Kenai LNG Project set the future trend for the LNG industry by becoming the first to use gas versus steam turbines for refrigerant compressor drivers. The Darwin LNG Project will continue to build on this history of innovation and evolution of the LNG industry by being the first LNG Plant to use high efficiency, low emissions, aero-derivative designed gas turbines for refrigerant drivers. The LNG Plant will also incorporate several other design features to reduce greenhouse gas emissions.

Environmental Design Features

Darwin LNG has selected the GE LM 2500+ aero-derivative design gas turbine as the driver for the refrigerant compressors in the facility. The LM 2500+ is comparable to the GE Frame 5D gas turbine in horsepower output but has an thermal efficiency of 41.1% compared to 30.3% from the Frame 5D. This improvement in thermal efficiency relates directly to a reduction of fuel required for an equivalent LNG production per gas turbine horsepower output. This reduction in fuel consumption results in two greenhouse gas benefits. The first greenhouse gas reduction benefit is related to the reduction in emissions due to a lower quantity of fuel burned. This impact is highlighted in Table 1 below, which shows the efficiency of different gas turbines and the relative impact to CO_2 emissions.

Table 1 Typical Gas Turbine Performance

Driver Type	Efficiency	Relative CO2 Emission
Industrial Design		
GE Frame 5C	29.3	1.03
GE Frame 5D	30.3	1.00
GE Frame 6B	32.4	0.93
GE Frame 7EA	32.7	0.93
Aero Design		
GE LM2500+	41.1	0.74
Coberra 6761	40.1	0.76
GE LM6000PC	42.6	0.71
Trent 800 DLE	42.5	0.71

The second greenhouse gas benefit is related to a reduction in the total feed gas now required for the same LNG production. The feed gas coming into the Darwin LNG facility also contains carbon dioxide that is removed prior to LNG liquefaction in the amine system and released to the atmosphere. The reduction in the feed gas associated with the lower fuel gas requirements therefore results in a reduction of carbon dioxide or greenhouse gas emissions from the facility.

A similar greenhouse gas reduction benefit comes the use of waste heat recovery on the LM 2500+ turbine exhaust that will then be used for various heating requirements within the plant. The use of this system will eliminate the greenhouse gas emissions that would have been otherwise released if gas fired equipment was used to provide these same heating requirements. The result of using waste heat recovery equipment is a reduction in greenhouse gases by approximately 9.3% of the total emissions without the installation of this equipment.

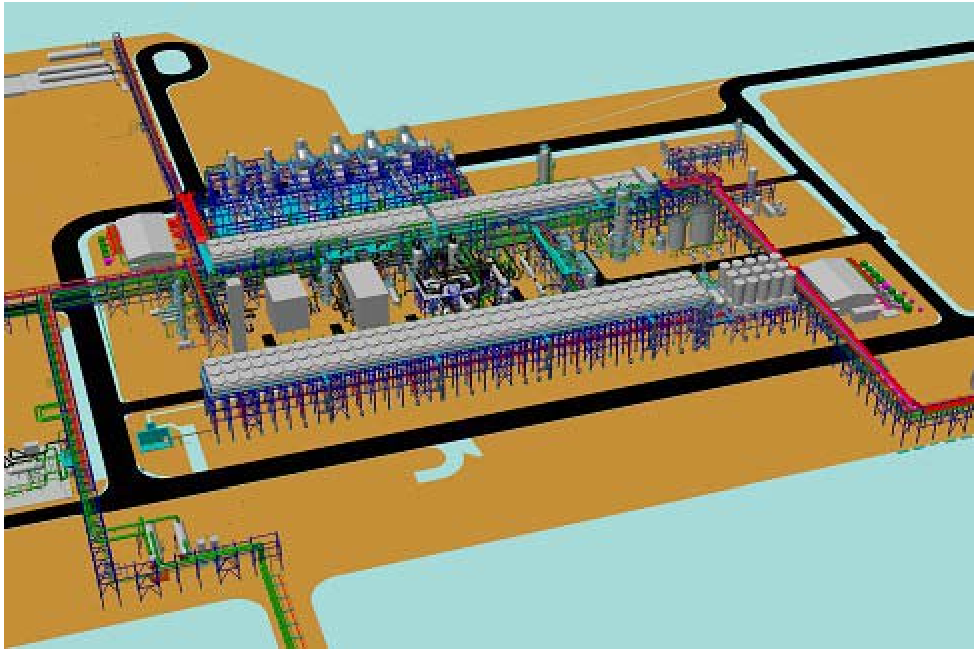

Figure 3 Process Area Model Layout

Additional greenhouse gas reduction benefits come from the use of additional ship vapor recovery equipment to maximize the recovery of vapors generated during ship loading. The installation of this equipment will minimize or eliminate any flaring that may occur during LNG tanker loading and the resulting greenhouse gas emissions. The use of this equipment will result in a reduction in greenhouse gas emissions by approximate 4.4% of the total emissions that would have otherwise occurred if these vapors were flared.

The addition of waste heat and ship vapour recovery equipment not only reduces emissions that would have been produced from fired equipment and flares, they also result in a reduction in fuel requirements for the plant. Again this reduction in fuel gas results in an additional greenhouse gas benefit as a result of the reduction in feed gas required for liquefaction and therefore the amount of carbon dioxide that is removed and released to the atmosphere. This use of this equipment will therefore result in an additional net reduction in greenhouse gas emissions associated with a reduction in carbon dioxide removal requirements by approximately 1.1% of the total emissions that would have occurred otherwise if this equipment were not installed.

The Darwin LNG Plant has also been designed to minimize nitrogen oxide emissions from the gas turbines. This will be performed by the injection of water into the LM 2500+ gas turbine. This water injection will allow the plant to minimize nitrogen oxides emissions form the gas turbine while still maximizing the flexibility in fuel gas compositions the gas turbines can use for various plant operating conditions. ConocoPhillips has been using water injection for NOx reduction on LM 2500 gas turbines in the United States for over 8 years.

Other Design Features

Besides being the first facility to use aero-derivative gas turbines in LNG Liquefaction, the Darwin LNG Facility will be the first in progressing several other design concepts in the LNG industry.

The Darwin LNG facility will use a single tank for LNG storage tank, which will also be one of the largest above ground LNG tanks constructed to date with a working capacity of 188,000-m^3.

The facility will also use a ground flare instead of a conventional stack to minimize visual effects from the facility and any intrusion on aviation traffic in the Darwin area. The facility will also include a broader use of vacuum jacketed piping in the storage and loading system for the facility. The first use of vacuum jacketed pipe in an LNG Plant was at the Atlantic LNG Plant in Trinidad. The Darwin LNG will include a more significant use of this pipe to improve thermal efficiency and reduce insulation costs for the facility.

The Darwin LNG project will also use MDEA with a proprietary activator for acid gas removal. This amine selection lowers the regeneration heat load required, and for an inlet gas stream containing over 6% carbon dioxide, this lower heat load results in a reduction in equipment sizes and a corresponding reduction in equipment cost.

Figure 4 Darwin LNG Project, Wickham Point, Australia

SHIPPING

Shipping for the project will occur through an F.O.B arrangement with Tokyo Electric and Tokyo Gas. Three ships will be used for the Darwin to Japan trade with two of these ships provided by Tokyo Electric and one by Tokyo Gas. The ships presently proposed will range in size from 125,000 to 145,000 m^3, however the LNG dock will be designed to handle ships down to a size of 89,000 m^3.

Darwin has an excellent natural deepwater harbour with a strong infrastructure in place to support the LNG shipping operations. Several studies and simulation efforts have been undertaken to insure safe LNG vessel passage. These have included additional or updated bathymetry along the navigation lane to verify bottom depth and harbour maneuvering simulations at the Australian Maritime College in Tasmania. The maneuvering simulations, which used design information for the 145,000 m^3 LNG vessel, provided operational information to address tug requirements, wind and current limitations, and navigation aid requirements. The bathymetry effort has demonstrated that a safe navigation lane is available without the need for additional dredging. The Darwin harbour experiences a wide tidal fluctuation, similar in range to what is seen at the ConocoPhillips Kenai LNG facility in Alaska. This 8 meter tide contributes to the natural cleaning action along the navigation lane and therefore no maintenance dredging is anticipated.

The Darwin LNG dock will consist of a combination of causeway and trestle, extending 1425 meters from the shoreline. Because the offshore facilities will be removing LPG's from the feed gas to the plant, no LPG's will be recovered onshore and therefore the jetty is being design for LNG loading only.

CURRENT PROJECT DEVELOPMENT

The Darwin LNG Project is being developed through a Lump Sum Turn-Key (LSTK) contract with units of the Bechtel Corporation. ConocoPhillips has an LNG relationship with Bechtel that goes back to the Kenai LNG facility in Alaska and a collaboration agreement for the use and development of the Phillips Optimized Cascade LNG Process. The LSTK contract was signed in April 2003 with notice to proceed with construction provided in June 2003. ConocoPhillips had released Bechtel back in late 2002 to begin various engineering and procurement activities to minimize the impact to the overall schedule pending these condition precedent approvals.

Site clearing began in June 2003, immediately after all contractual condition precedents were satisfied. The LNG storage tank will be constructed under a Bechtel subcontract to a consortium consisting of Theiss and TKK. Theiss is a major Australia contractor and TKK is a Japanese company with extensive experience in LNG storage tank engineering and construction. TKK has completed LNG storage tanks of similar size to the one under construction at the Darwin facility, however the Darwin LNG tank will be slightly larger making it the largest above ground LNG tank under construction. The

LNG tank subcontractor was mobilized on site and began tank construction in September 2003.

Bechtel will use a combination of local and Australia hire for craft support on this project. A camp has been established between the town of Darwin and the plant site and workers from the camp will be bussed to the plant site each day. A project schedule with major milestones is shown in Figure 5.

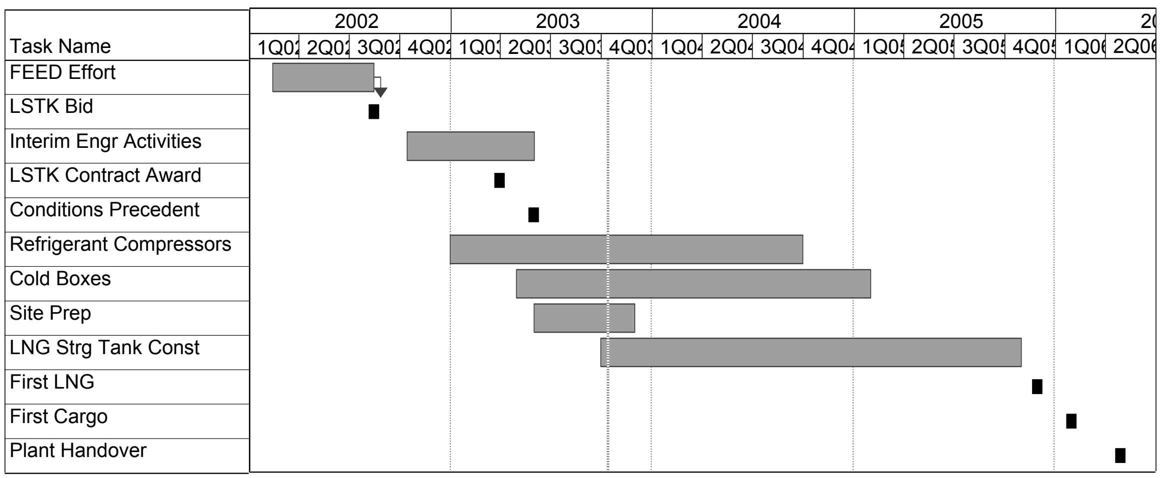

Figure 5 Project Schedule

CONCLUDING REMARKS

The Darwin LNG Project will build on the long-term relationship that ConocoPhillips, Tokyo Electric and Tokyo Gas have developed and nurtured since the first LNG cargo was delivered from the Kenai LNG plant to Japan in 1969. With the development of the Darwin LNG Project, this relationship will mature to new heights as the three companies join with Bayu-Undan partners INPEX, Eni, and Santos to not only expand their LNG seller and buyer relationship, but also become partners in the Bayu-Undan offshore development, a 3 MTPA LNG plant at Darwin, and the pipeline infrastructure that will connect these two world class projects.

Also, in keeping with the performance spirit that is a trademark of ConocoPhillips, the Darwin LNG Project will continue to drive innovation in the LNG industry through the use of aero-derivative gas turbines and the integration of several emissions reduction technologies.