Fast tracking fuel supply in Chile

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Supplying energy needs

Chile has a dependence on imported natural gas, which supplies a large proportion of their electricity generation. At present, gas imports are predominantly via pipeline from Argentina. However, in 2004 Argentina decided to reduce its gas exports to Chile, forcing a dependence on more expensive fuel oil to make up the difference whilst an increased hydroelectric capacity is developed. In order to reduce this dependence and diversify its gas supply sources, the Government of Chile decided to build an LNG import terminal at Quintero Bay, about 155 km north west of Santiago. With increasing demand and a growing uncertainty of supply from current sources, there was significant pressure to deliver an operational terminal as quickly as possible.

LNG or liquefied natural gas is natural gas (primarily methane) that has been converted to a liquid form for ease of transport. The gas is chilled to -163°C and in this state occupies about 1/600th of the volume at close to normal atmospheric pressure and room temperature. It is then loaded into specially designed ships for shipping to the points of gas demand. When the ships arrive at the LNG import terminal the liquid is offloaded and stored in insulated tanks. The liquid is then drawn from the tanks and heated to turn it back into its gaseous form. This process allows countries such as Chile to economically source gas from remote locations around the world.

Beginning in 2006 BG International entered into an agreement with Chilean partners (ENAP, Endesa and Metrogas), to form the GNLQ Joint Venture to develop an LNG import terminal. Along with the requirements for future expansion, the Quintero Bay terminal was required to deliver 10 million cubic metres per day of gas by mid 2009. The terminal will ultimately receive around 2.5 million tonnes of LNG per annum, which is equivalent to around 40% of the Chilean gas demand, and have the flexibility for future expansion.

HR Wallingford came onto the project at BG's request and worked as part of the project team to identify the location of the marine facilities in Quintero Bay, optimise the layout and design of the LNG marine facilities, develop the design of the intake and outfall system to supply seawater for regasification, and to investigate methods for fast-tracking gas supplies.

Defining the challenge

The proposed development infrastructure will comprise:

- Marine facilities for receiving LNG carriers
- LNG storage tanks
- Re-gasification plant using seawater as the heating medium

The initial process was similar to many of the LNG projects in which HR Wallingford have been involved and resulted in the development of a list of primary marine development tasks.

Figure 1. Planned location of onshore facilities.

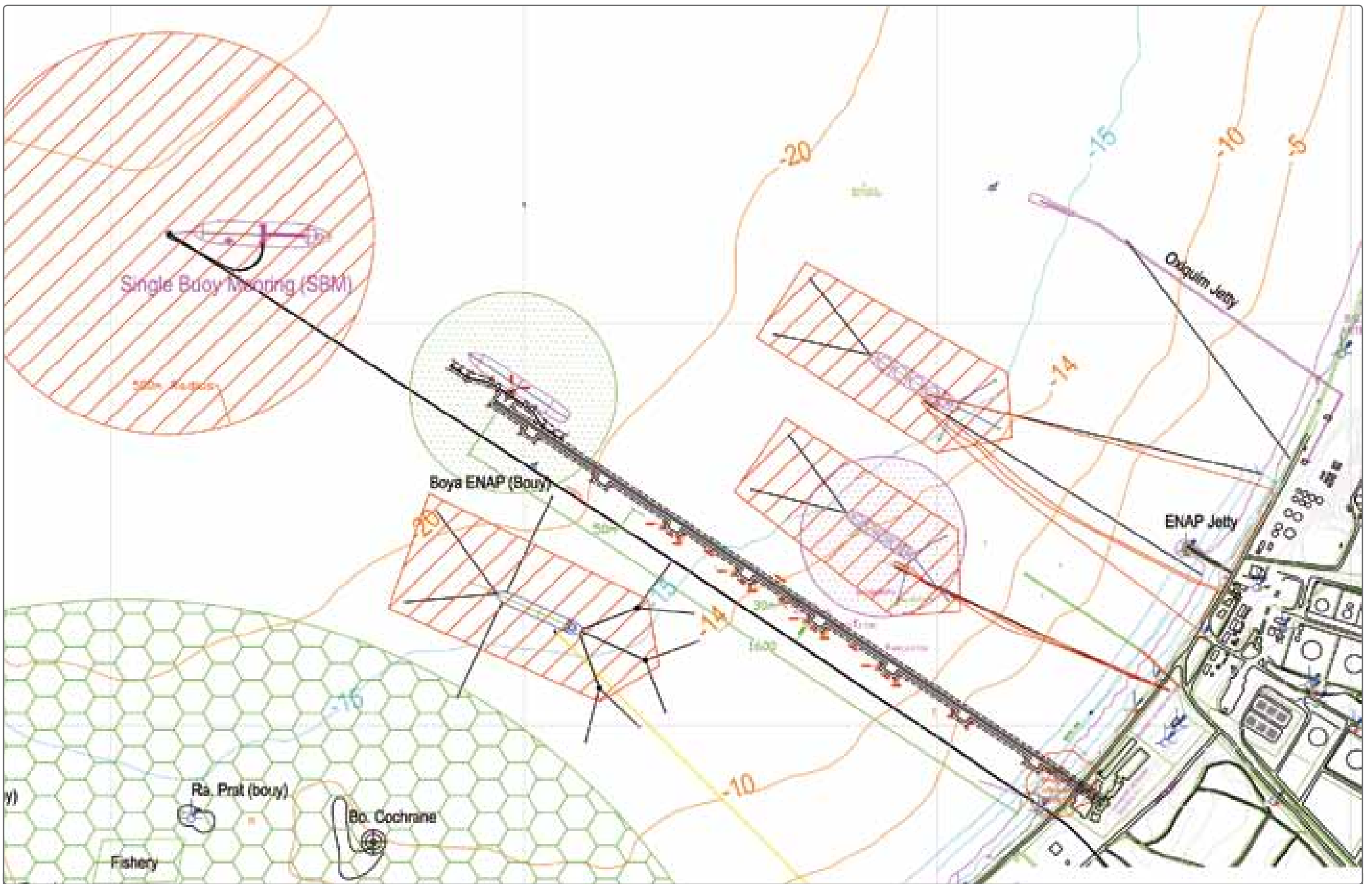

Figure 2. Planned location of marine facilities.

These were defined as:

- Develop a functional requirements specification
- Develop an understanding of the bay environment
- Identify the layout of marine facilities that would best meet the functional requirements
- Develop design concepts, costs and schedule for construction

The plan was to locate onshore facilities (storage tanks and re-gasification plant) in the centre of Quintero Bay. This location was fixed (due to space constraints) as being between two tank farm areas owned by ENAP, on land that is presently part of the ENAP crude oil and products terminal. The approximate location of the onshore plant is shown in Figure 1.

Quintero Bay already had a number of other existing marine facilities and pipelines. It was therefore important that the LNG project marine facilities did not have an adverse impact on the existing marine infrastructure and operations. The existing uses are shown in Figure 2, which illustrates the lack of available space.

In order to minimise berth downtime and storage requirements, the marine facility functional requirements were to have the ability to accept a wide range of LNG carriers at the berth location. In addition, to minimise cost and schedule, the jetty also needed to be close to the plant. The green areas in Figure 2 illustrate the berth location and show exemplar safety zones. This clearly highlights the difficulties that can be faced when attempting to integrate LNG into an existing port infrastructure.

Use of navigation simulation to confirm location

Real-time navigation simulation is used as a standard technique for the design and optimisation of dredged areas and channel layout, and in confirming the accessibility of berths for different ships. It is also used for the familiarisation of marine pilots and tug masters. This particular project took the use of navigation simulation one step further, by utilising real-time full-bridge simulation as a method of assessment and visualisation of the proposed layout and overall project. This enabled a common and accurate perspective to be gained which allowed constructive discussion on marine operations with all the involved parties. Ultimately this resulted in all relevant parties agreeing that they could operate with the LNG facilities in the proposed location and saving significant amounts of time that could have been lost to misinterpretation. This meant that the Maritime Concession permit could be granted and allowed the project to proceed without delay.

Metocean data and studies

Initially, metocean conditions in the bay were developed using available data and models. This allowed the operational and extreme conditions to be characterised, and then allowed the requirements for additional survey campaigns to be scoped and specified. As data came in, the accuracy of the metocean design data set was increased and uncertainties were reduced. This approach ensured that the required data was available in a timely manner, in advance of decisions being made. It also allowed progressive refinement and optimisation of the design through the project cycle.

Intake and outfall design

Seawater was to be used as the most economic medium to heat the LNG to allow re-gasification into standard pressure natural gas. This technique requires a supply of seawater to act as the heating medium, however the technique needs careful handling of intake and outfall in order to minimise environmental impact and reduce sediment ingress. Studies made use of the data and models developed in the metocean work and used these as inputs to computational fluid dynamics (CFD) and physical models. This approach enabled the design to be optimised from an efficiency, cost and environmental standpoint.

Figure 3. Marine facilities and pumping station, construction status October 2008.

Fast track

A key issue was how to 'fast track' the early delivery of gas. The construction of LNG storage tanks is commonly one of the longest lead-time elements within the development of an LNG plant and therefore a method to move this element off the critical path was needed. A solution was developed that used an LNG vessel, semi permanently moored at the berth, which would effectively provide the LNG storage required, with the vessel unloading the LNG at the gas 'send out' rate. Nevertheless, in order to provide a constant flow of gas during times when the berthed ship was being changed over or when weather patterns caused unloading to be suspended, a small onshore LNG storage was still necessary. This was achieved by reducing the size of the first LNG tank which removed this issue from the critical path and provided a significant schedule improvement.

Because the storage requirements were proportional to the amount of time the vessel was unable to discharge cargo due to poor weather conditions, it was critical that the vessel mooring system was optimised to minimise berth downtime. This was achieved using an experience based design process in conjunction with metocean models and HR Wallingford's proprietary dynamic mooring analysis and logistics simulation tools. This also allowed the specification of the size of the onshore storage tank that would minimise risks of supply interruption (for both 'fast track' and subsequent normal operations).

Under construction

At the time of writing the project is under construction by CB&I and is on schedule to meet the required delivery dates. Figure 3 shows the construction of the marine facilities and cooling water intake/outfall.

Planning for the terminal operations is underway. HR Wallingford is currently running integrated LNG familiarisation courses for the Chilean pilots, tug operators and LNG ship masters using our navigation simulation facilities. We are also involved in site-specific weather forecasting services to allow planning of marine operations.

This project is of significant economic importance to Chile and one that redefines the meaning of 'fast track' in the LNG industry.

ABOUT THE AUTHOR

Tim Mundon completed a PhD at Edinburgh University in renewable energy before joining HR Wallingford in 2004. Working initially with the maritime group, Dr Mundon handled a variety of complex physical model studies over a wide range of projects before eventually moving to Houston, USA in 2007. He is now responsible for managing HR Wallingford's North and South American projects.

ABOUT THE COMPANY

HR Wallingford carries out advanced research and consultancy relating to civil engineering and the water environment. It provides a range of specialist planning, design and engineering services to allow project developers to understand and manage water based risks at every stage of a project's lifecycle.

HR Wallingford has the technology, expertise and experience to deliver appropriate and effective solutions to complex development problems. Over a period of more than 60 years HR Wallingford has worked on projects in over 60 countries and across six continents.

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