LNG INDUSTRY

Surveying on the Gorgon Jetty Project on Barrow Island, Australia

Construction of the largest single resource development in Australia's history is nearing completion on Barrow Island, a Class A Nature Reserve located 60 km (37 miles) off the coast of Western Australia. Stringent conditions for the Gorgon Project required the team at CADS Survey use ambitious surveying techniques and a full array of technology solutions.

Barrow Island is described by some as Australia's answer to the Galapagos Islands: the 202 km^2 (78 $miles^2$) island and its surrounding ocean are home to diverse and unique fauna, including marsupials, reptiles, sea mammals and coral. Due to its isolation, the island offers a rare glimpse into what an untouched Australian continent might have looked like before European colonisation. For this reason, the island is classified as a Class A nature reserve.

The Gorgon Project

The Gorgon Project includes a three-train, 15.6 million tpy liquefied natural gas (LNG) facility and a domestic gas plant with the capacity to supply 300 TJ of gas per day to Western Australia.

Subsea infrastructure will transport natural gas from the Gorgon and Jansz-Io fields to the LNG plant on Barrow Island. From there, LNG destined for domestic use will be piped to the mainland and LNG for international markets will be off-loaded from a jetty.

Gorgon Jetty construction

CADS Survey was contracted by Leighton Contractors to perform surveying for Gorgon's 2.1 km (1.3 mile) long loading jetty, including structural, mechanical and hydrographic surveys. They also developed and managed the necessary automated module guidance systems. Simon Bush, co-owner of CADS Survey, was the Survey Manager of the Gorgon jetty project.

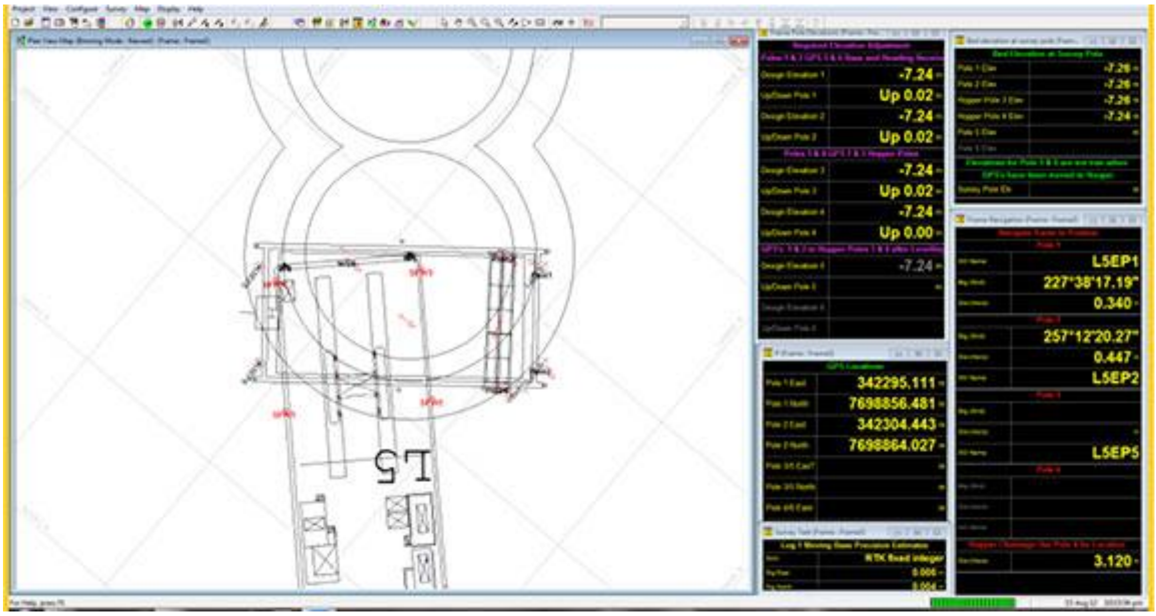
For much for their hydrographic surveying CADS Survey relied on a survey vessel equipped with echo sounders, a motion reference unit, a gyro, and an RTK GNSS system. The R2Sonic multibeam echo sounder was well suited to shallow water as the Ceestar single beam provided quality control for the multibeam system. The TSS DMS-05 motion reference unit measured sea rotation and acceleration to give correction values for heave, pitch and roll. The Trimble RTK GNSS system, a Trimble SPS852, used CADS Survey's GNSS base station setup at the LNG plant construction site to deliver centimeter-accurate 3D positions.

Surveying work commenced in earnest with the placement of caissons on the sea floor. These round concrete shells were then filled with heavy gravel to function as piles for marine structures such as bridges and jetties. The use of caissons protected Barrow Island wildlife from the disruption caused by traditional percussion piling.

Screed was used to form a level base for the caissons. During the screeding process, the Trimble® SPS855 GNSS Modular Receiver and Trimble SPS555H Modular Add-On GNSS Receiver were attached to the crane hook, barge, and screed frame to provide guidance. The crew used Trimble HYDROpro™ marine construction software to visualize the process as screed frames were accurately positioned and leveled. Dips and ridges detected by the hydro vessel used by CADS were postprocessed on the control barge and the results were reported back before the frame’s positioning was signed off. Although this process took approximately two hours, the time delay was inconsequential.

Bush commented: “It takes hours to move a barge, because each one has 4-6 anchors to keep it steady. So real-time feedback wasn’t required for this phase.”

The survey vessel was again used to verify that the extents and elevations of the gravel beds were satisfactory once screeding was complete.

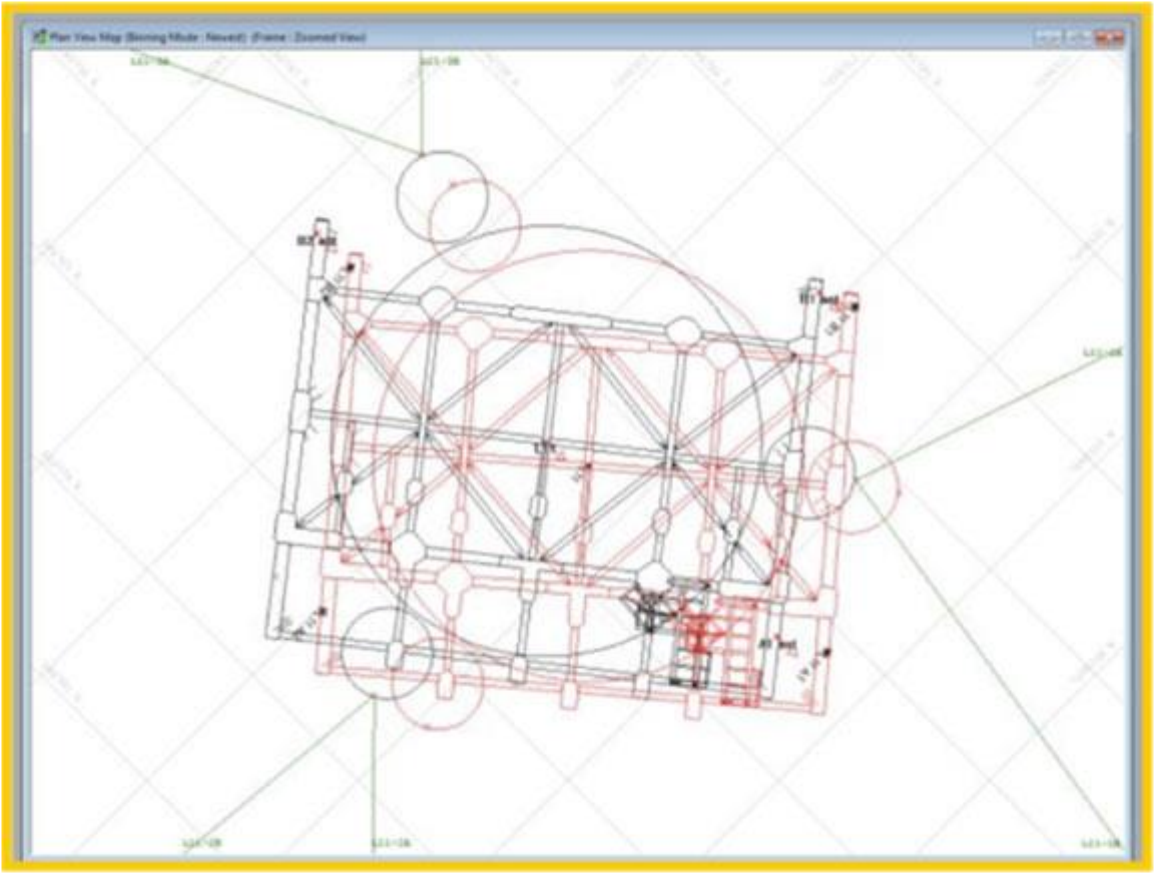


The GNSS guidance system, with devices attached to crane hook, barge and screed frame, accurately positioned and levelled the screed frame to design location.

Caisson placement and stabilizing

For accurate caisson placement, the upper beam of each caisson was mounted with three to four Trimble GNSS receivers, Trimble SPS855 and SPS555H, which wirelessly transmitted position data to the HYDROpro software. In the control room, located on the caisson floating barge, an operator could clearly see on-screen the position and tilt of the caisson in relation to the design location. A team that included engineers to determine how much water to pump into the caisson to keep it level, a hydrographic surveyor, and a winch operator, watched the visualization on three large screens. HYDROpro displayed winch lines to help the operator determine which one to use to move the caisson, plus information such as vertical-distance-to-touchdown and caisson centre location. The latter screen was used when the caisson was close to design location.

Caissons on a barge travelling to the design location.



The Trimble HYDROpro screen depicts the caisson actual position in black with the required design position in red. Winch lines are also drawn on the display to help the operator determine which winches to use to move the caisson.

Integrated surveying: static GNSS enhances total station traverse

To solve the problem of poor network geometry for total station observations, CADS Survey observed primary control points with static GNSS—these tied back to the high-order network on Barrow Island. The baselines were observed for 12 hours or more to negate any subtle movements caused by environmental factors.

Bush said: "Caissons sway so you can wander off with your traverses. The static GNSS tied everything back to the Barrow island network. It was an insurance against angular drift in the total station traverse."

Caissons were placed 80 m (260 ft) apart. At approximately every 500 m (1600 ft) survey pillars were installed on a caisson. Further static GNSS baselines were observed to each one.

Achieving level accuracy

In strategising how to ensure both ends of the jetty met in the middle, CADS Survey decided to try long-range reciprocal trigonometric heighting.

CADS Survey consulted with Haefeli-Lysnar, their local Trimble dealer, and purchased two Trimble S8 Total Stations with Long Range FineLock™ technology. These instruments, designed for high-precision applications, can detect targets without interference from surrounding prisms to 2500 m (8200 ft), achieving 1 cm accuracy.

The team set up the total stations to face each other from neighboring caissons, and observed from both ends of the line. They measured at exactly the same time to derive mean elevation differences while minimizing the effects of refractive turbulence.

"The Trimble S8 instruments didn't skip a beat," said Bush. "They were completely reliable, with repeatable results even on our longest observation."

Solving access problems with 3D scanning

When pipe modules were installed, they came with straight lengths of pipes already installed. CADS Survey's next task was to deliver accurate pipe end measurements.

After careful testing CADS Survey purchased a Trimble FX™ 3D scanner. Rope access climbers, with sea beneath them, bolted the instrument in place close to pipe racks. The survey team positioned themselves nearby with the scanning PC running Trimble RealWorks® software. The high-precision Trimble FX instrument provided a clean representation of pipe ends that they could model with certainty.

Gorgon Jetty Project completion

On the Gorgon jetty project, the CADS Survey team greatly enlarged its surveying capabilities and technology.

Bush concluded: “The LNG jetty and construction sequence was not a traditional land-to-jetty-end build, so it provided a great surveying challenge. To maintain high accuracy in the build, we really had to use the latest surveying technology available.”

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