Mario Figueira, Halliburton, Brazil, describes Brazil’s largest and deepest precommissioning operation.

The Petrobras Rota 3 pipeline (Figure 1) was constructed and installed offshore Brazil by Allseas Marine Contractors. The 297 km long gas export pipeline with a diameter of 20 - 24 in. has two inline Ys and seven inline Ts with the purpose of connecting a series of pre-salt gas production fields and other pipelines from the Lula Norte region to Jaconé Beach, Maricá. The pre-salt area consists of carbonates located subsea below the salt layer.
which can be deeper than 7000 m. After construction of the 10 km ultra-shallow and 48 km long onshore sections, this new pipeline will communicate with the COMPERJ project terminal for gas processing and treatment. The pipeline has the capacity to transport 18 million m$^3$/d of gas.

The Rota 3 pipeline installation began in 4Q16. The 297 km long pipeline was installed from a water depth of 58 m to a maximum of 2296 m using Allseas vessel Solitaire during the construction campaign. The flooding, gauging and hydrotesting operation was executed by Allseas vessel Calamity Jane.

Halliburton was awarded a contract for the dewatering, conditioning, nitrogen purging, and monoethylene glycol (MEG) gel pumping activities for the pipeline precommissioning following extensive technical and commercial discussions for several project execution options that had the support of the pipeline and process services global team from the UK and the Netherlands.

This project represented the largest and deepest precommissioning campaign in a single pipeline section performed in Brazil, using 100% local personnel for the project management and engineering scope of work.

The Rota 3 main dewatering operation began in 2Q17 after the completion of the pipeline installation and hydrotesting. The project required the Lorelay vessel, selected for its ability to accommodate the largest dewatering spread ever used globally. The spread was composed of multiple feed air compressors, drying plants, booster compressors, and positive displacement pumps divided into three work stations distributed across the vessel. In addition, the Calamity Jane vessel was necessary to accommodate an MEG collection system, as no subsea discharge of this product is allowed in Brazil and the pipeline dryness is measured through MEG sample analysis. This MEG collection spread was composed of a custom-engineered 2500 m long, 3.5 in. coiled tubing system, which included high-pressure manifolds and a vertical buffer tank to allow for the MEG and gas separation before transportation to the storage tanks.

More than 938 t of precommissioning equipment was transported from the Halliburton base in Macaé to the Rio de Janeiro port using articulated trucks, over a distance greater than 250 km. All equipment loads were planned by the Halliburton transport department to reduce the number of trucks and avoid local traffic congestion at the port area, in the meantime complying with regional restrictions.

The Rota 3 project required the largest high-pressure dewatering spread ever installed on a vessel for a precommissioning operation globally. This was only possible because of Allseas’ flexible approach to apply lessons learned from previous Halliburton deepwater projects, to understand the challenges of such projects, and to modify the Lorelay and Calamity Jane vessels to optimise the areas onboard. In addition, it was necessary to modify the vessels’ facilities capacity to accommodate the large amount of equipment required for the operation.

Because of Allseas’ ability to house the necessary equipment in combination with Halliburton expertise in customised solutions, this dewatering spread can be considered a milestone in the industry, particularly for large pipelines located in deepwater regions. The high pressure spread was able to deliver 18 000 ft$^3$/min. of dry compressed air for 24/7 service.

To deliver the Rota 3 precommissioning service while also adhering to operator specifications and engineering a suitable design in the planned time frame, a multi-discipline structure was necessary to allocate air compressors, boosters, and nitrogen membrane units from various countries. In addition, because of deck space limitations and the permanent structures onboard the Lorelay vessel, Halliburton proposed to use double-stacked equipment (Figure 2) based on experience from previous projects to help maximise deck space utilisation. New solutions were also necessary to help minimise equipment overheating issues caused by the limited distance between the units.
The dewatering operation was performed from the pig launcher at 58 m water depth to the deep end vertical pig receiver. This direction was necessary because of the reduction in diameter from 24 - 20 in., which only allowed pig passage in one direction. This made the Rota 3 project the longest precommissioning campaign ever performed in Brazil, requiring more than 874 hours of equipment running time to achieve the desired result in accordance with the specifications.

For the MEG collection operation onboard the Calamity Jane vessel, Halliburton was able to develop new engineering solutions by designing a new 3.5 in. dia. x 2500 m long coiled tubing frame using lessons learned from previous projects to help improve the equipment and operational performance. Further developments were necessary to provide additional safety precautions following a competitor report related to industry learnings from a catastrophic event in February 2017. The MEG collection operation was led by local personnel, correlating MEG purity to the pipeline dewpoint (dryness criteria) to help avoid and prevent hydrate formation during pipeline startup for initial gas production. In this way, it was possible to collect MEG samples and allow analysis to be performed, which concluded the pipeline was conditioned with MEG within the project acceptance criteria. This operation was completed safely and successfully 30 August 2017.

Following the completion of the MEG collection operation, the pipeline, which contained dry air at this stage, was depressurised to perform the nitrogen purging operation at low pressure with a single pig run. The purpose was to remove the dry air and leave the pipeline only with dry nitrogen. For this operation, the nitrogen purity remaining inside the pipeline was required to be better than 4% to help prevent an explosive atmosphere when the pipeline commenced gas receipt during the production phase. The Rota 3 nitrogen purging campaign was completed 22 October 2017.

To enable these precommissioning operations, Halliburton had to use multi-skilled personnel from different service lines, such as pipeline and process services (PPS), testing and subsea (TSS), Halliburton production services-coil tubing services (HPS-CT), Halliburton production services-nitrogen services (HPS-N2), and internal equipment maintenance (IEM) departments from Brazil. In addition, extra operational support from Trinidad and Tobago, the US, and Canada were instrumental for performing the project execution in a safe manner without incurring any reportable incidents.

The final MEG gel pumping operation of a 400 m section of 24 in. pipeline was completed on 12 February 2018 and has followed the Rota 3 project trend of achieving operator specifications while maintaining focus on the target to zero health, safety, and environmental incidents.