WHEN HIGH OIL PRICES PUSH FAST TRACK SUBSEA DEVELOPMENTS : THE TOTAL FORVIE NORTH PROJECT PIPE-IN-PIPE EXPERIENCE

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ABSTRACT

With the rise of oil prices, clients are willing to accelerate all the phases of field developments. There is then a natural temptation to choose field-proven solutions that have demonstrated their efficiency and quality in the past.

For the Forvie project, TOTAL needed a design capable to handle high operating pressures (520 bar) while providing outstanding thermal performance (U-value better than 0.8W/m².K). Another key issue for the oil companies (operators) is to open the pipelay competition and increase the chances to find an available vessel.

To answer this acute scope of work, ITP proposed a pipe-in-pipe flowline system, combining an original quick field jointing procedure (6 minutes cycle time) with a highly efficient passive insulation (based on a proprietary insulation and offering a compact design). Due to the field-proven technique (with an actual thermal performance world record of 0.35W/m².K) and the capacity to mobilize a fabrication yard, ITP was awarded the contract including the engineering, procurement, fabrication and offshore assistance to installation.

One year later, the last double joint of the 33km long pipe-in-pipe tie-back was S-laid in the North Sea on time and the field has been onstream since December 2005.

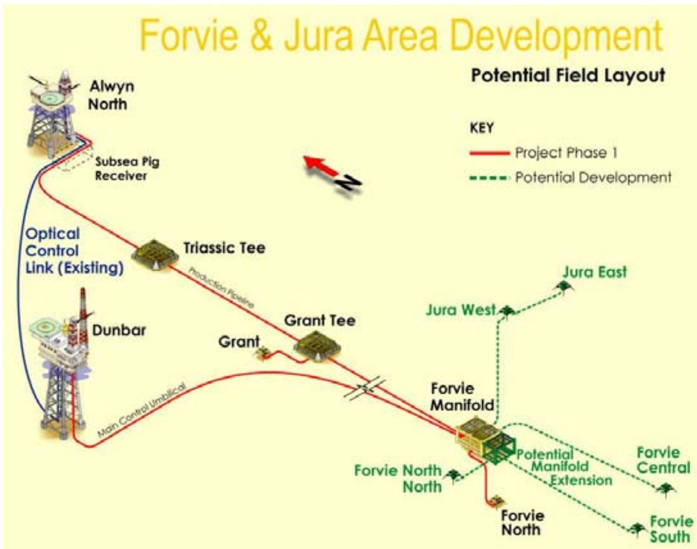
The paper will address issues such as the tight planning (1 year from contract award up to offshore installation completion), logistics, welding (double joints with a heavy wall inner pipe), the fabrication process and the offshore installation phase.

INTRODUCTION

When TOTAL decided early 2004 to develop its Forvie North field located in the UK North Sea, with the challenging objective of first oil by the end of 2005, the project team was confronted with an incredibly ambitious schedule at a time of shortages of key resources in the oil and gas industry. To meet the target, a specific contractual approach was selected in order to be able to make technical choices that contributed to meeting the overall schedule. The Forvie North field first oil was produced on 29 December 2005.

The Forvie North field is located in Block 3/15 of the UK North Sea and is located approximately 16.4 km from the Dunbar platform and 34 km from the North Alwyn 'B' Platform (NAB), in a water depth of 120 m. Forvie North is a high-pressure gas condensate reservoir, with a maximum pressure of 520 barg. This field, owned 100% and operated by TOTAL E&P UK, was discovered early 2002 and was started up in December 2005. Because building a dedicated production platform was ruled out for economic reasons, the field was developed as a subsea tieback using a 15" pipeline carrying the fluid to the NAB platform, where water and condensate are separated from the gas.

Fig 1: The Forvie North Field development.The Pipe-in-Pipe system goes from the Forvie manifold to the Alwyn North platform.

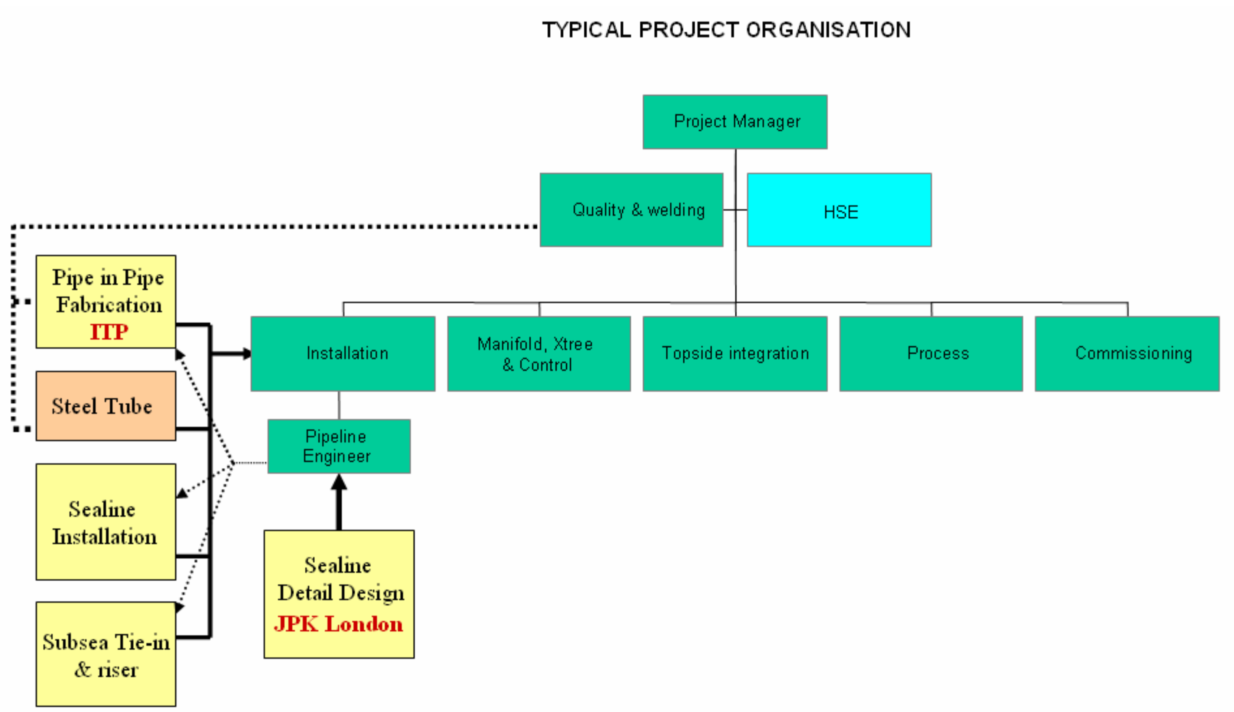


For this development, managed as a fast-track project which was internally sanctioned in the first half of 2004, ITP successfully met a series of technical challenges imposed by such a tight schedule and selected field proven designs that proved their efficiency in the past.

PLANNING ISSUES & CONTRACTUAL STRATEGY

In this period of high activity in the O&G industry, instead of going through the common EPC scheme, TOTAL mobilized a project team who managed all the subcontracts associated with the subsea tieback, from the procurement of the manifold and the steel pipes to the various offshore operations contracts (pipelay, subsea tie-ins).
Around seven main suppliers and seven contractors (amongst which ITP - provision of 33km of pipe in pipes) were involved in the development, under the direction of the Total project team.

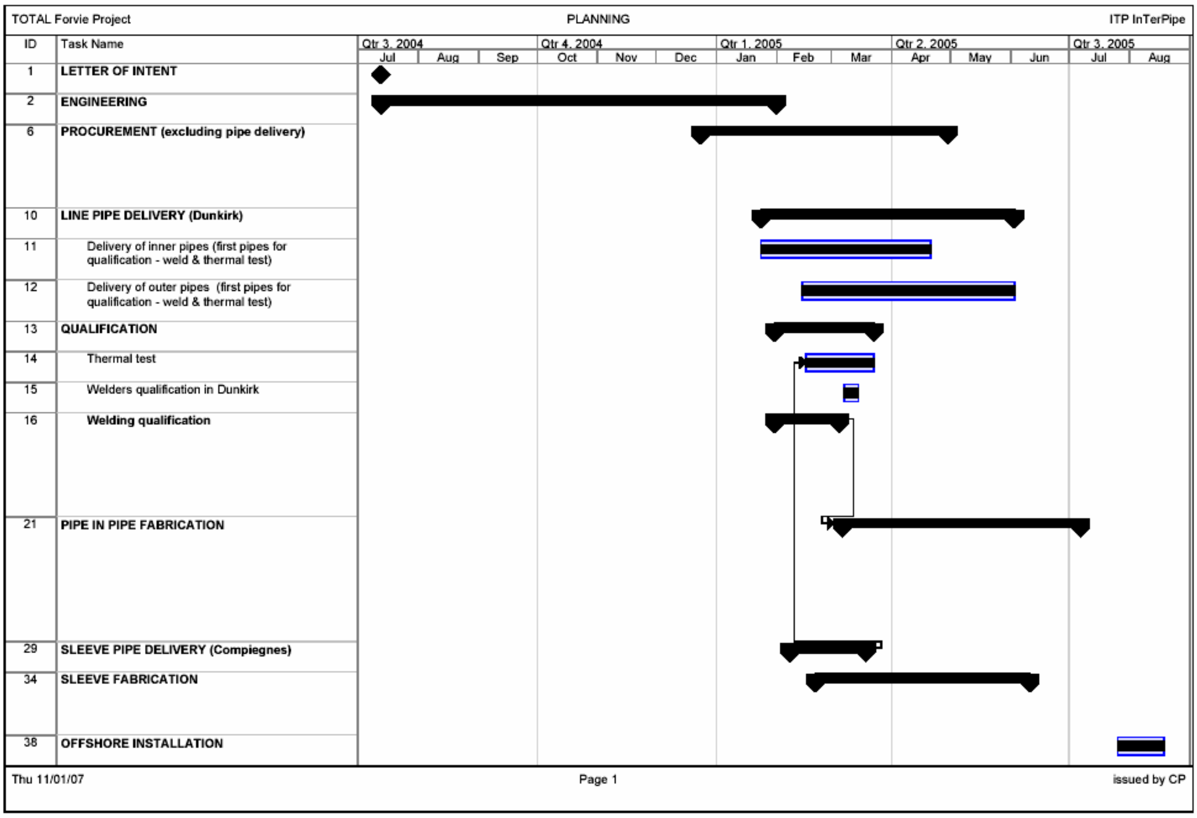
Fig 2: Contractual strategy



This project contractual architecture allowed to take rapid decisions and select field proven designs in order to meet the tight schedule. Also, the pipe in pipe that was offered for Forvie North incorporated past experience and learnt lessons from previous North Sea projects and other deep water designs to ensure a maximum robustness.

This early design selection contributed towards meeting the main deadlines such as ordering steel pipes, subsea components, and even contracting the Pipe-in-Pipe contractor, while still negotiating with the offshore contractors. For instance, the 34.5 mm wall thick 15” pipes, designed for a pressure of 520 barg, representing about 10,000 tonnes of seamless steel tubes had to be ordered as soon as possible given the situation at that time in the world steel market.

Fig 3: Project planning – ITP scope



From a technical point of view, the constraints imposed by the operating conditions (high pressure combined with a 95°C design temperature) were the first challenges to be met. To minimize the detailed design period, it was early on decided to go with a pipeline to be trenched and buried or rockdumped. This approach, in contrast to being laid on the seabed, has proven to be a reliable design approach for such long, high-temperature pipelines. Indeed, it alleviates all uncertainties related to lateral buckling design and the associated fatigue in operation. Therefore, the pipe design (wall thicknesses…) can be defined quite rapidly, with a minimum risk of modifications during the execution of the project.

FLOW ASSURANCE & PIPE DESIGN SELECTION

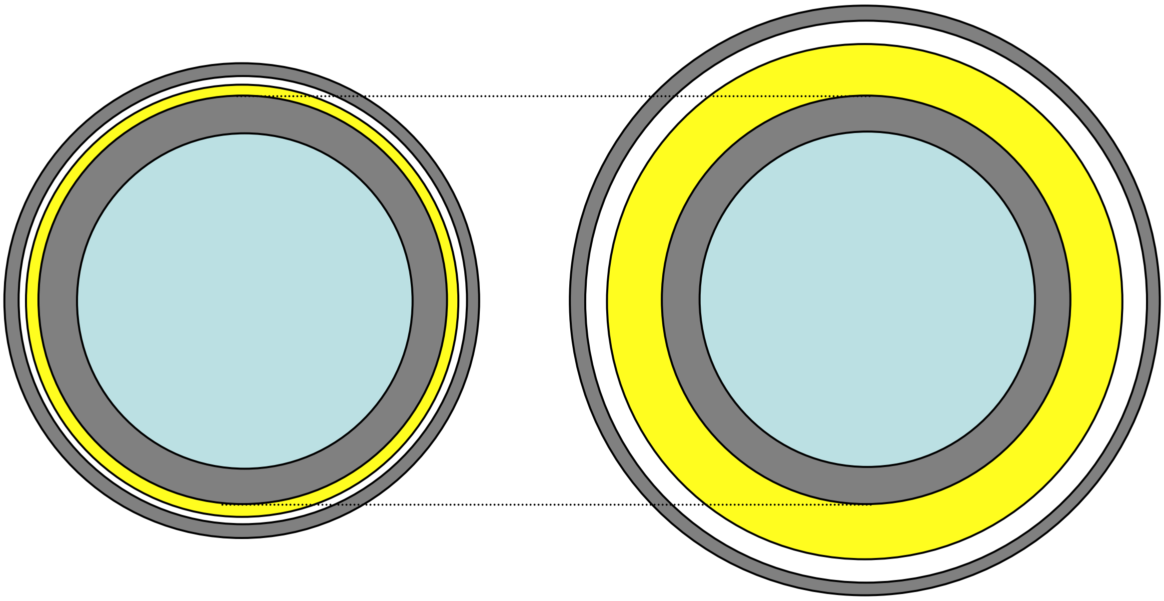
Flow assurance of the gas condensate through the 33 km long underwater pipeline was also critical for operability. The thermal performance imposed on the pipeline to avoid risks of blockage, was driven by both:

- the requirement for a minimum steady-state arrival temperature at the NAB topsides, which should always exceed the wax appearance and hydrate formation temperatures;
- a minimum survival time in the pipeline before the hydrate formation temperature is reached and the system needs to be depressurised, in case of production shutdowns.

The initial flow assurance design led to an overall heat transfer coefficient better that 1 W/m^2*K for the pipeline - a value which cannot economically be achieved offshore using wet insulation.

ITP InTerPipe was therefore contracted for the provision of the Pipe-in-Pipe system. ITP InTerPipe is a contractor dedicated to Pipe-in-Pipe systems for both high temperature and cryogenic applications. This pipe-in-pipe technique, already in use in the North Sea for 10 years for a previous HP/HT project, provides high thermal performance while keeping the overall system compact, due to the use of the ITP proprietary high-performance, microporous, Izoflex insulation.

Fig 4: Comparison between pipe in pipe designs



ITP design with Izoflex®
381mm/443mm

Pipe in pipe design with PU foam
381mm/550+mm

To gain even more flexibility in operations, the operator and the Pipe-in-Pipe contractor agreed to improve the thermal performance of the system to 0.8 W/m^2*K based on the inner pipe ID, including field joints (which means a U-value of 0.65 W/m^2*K based on the OD). This was achieved by a 15"/17.5" pipe-in-pipe system. This design U-value was first confirmed by full scale testing during Pipe-in-Pipe fabrication and again after field production start-up. It is currently one of the best thermal performance achieved in the North Sea.

The choice of the Pipe-in-Pipe system was critical in terms of flow assurance but also in terms of offshore installation. When this pipe in pipe design was selected in 2004 to develop the Forvie North field and to start up the production by the end of 2005, pipelay vessel availability for 2005 was uncertain.

As the project strategy was to purchase the steel pipes and the Pipe-in-Pipe first, and to free issue the insulated joints to the pipelay contractor, the Pipe-in-Pipe had to be installable by every offshore contractor. Moreover, the field jointing process had to be as rapid in order to shorten as much as possible the required pipelay window, increasing the vessel availability. The project team selected the ITP proprietary field joint featuring only one weld to perform offshore (contrary to sliding pipe in pipe designs or Half shell field joints, which necessitate at least 2 offshore welds per joint).

Due to a highly insulated steel sleeve that is slipped over the field joint area in order to ensure the thermal and mechanical continuity of the system at the field joint, only the inner pipe, carrying the fluid, needs to be welded offshore. This allows dedicating more working stations to the welding of the inner pipe and NDT onboard the pipelay vessel, which then provides a much faster layrate for pipe-in-pipe than other field jointing methods. This unique field joint had already been successfully used in West Africa for several projects including in deepwater environments. The Forvie project was the first application of such a cost-efficient technique in North Sea.

Fig 5: ITP pipe in pipe offshore field jointing operations

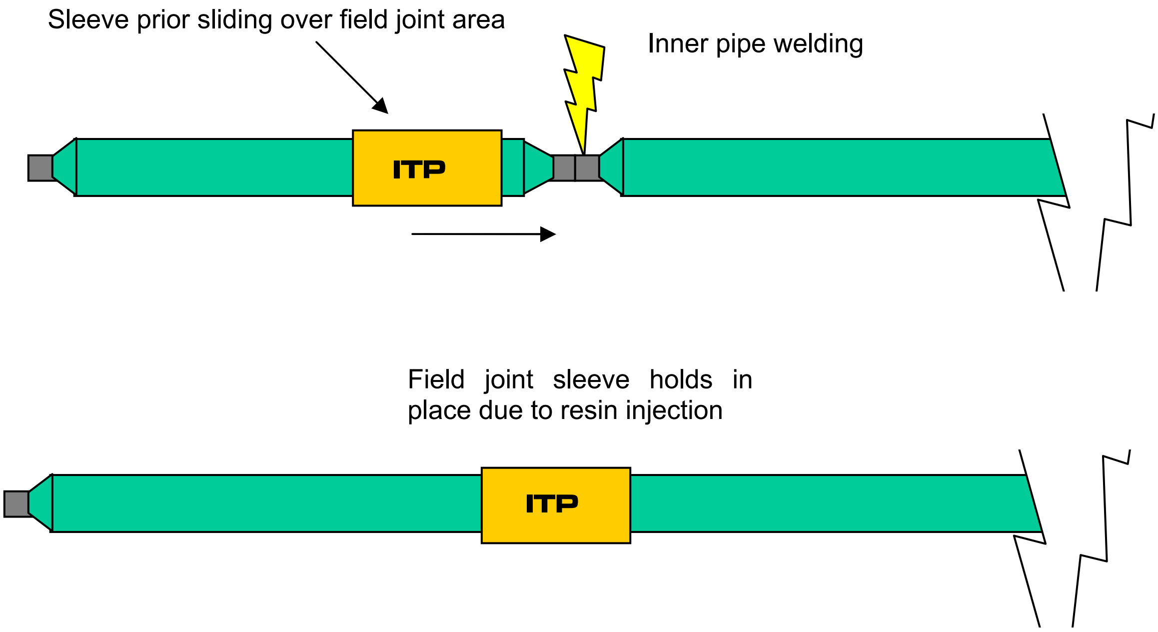
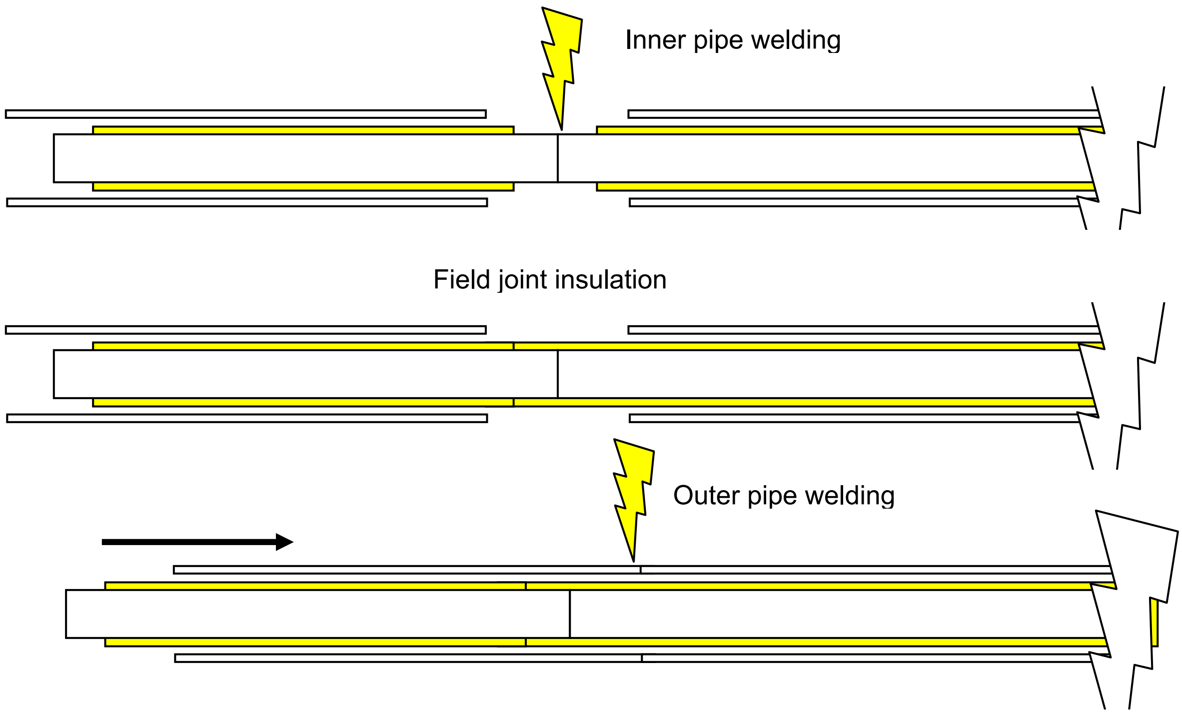


Fig 6: ITP field joint sleeve on the firing line

Fig 7: sliding pipe in pipe offshore field jointing operations



For the detailed design of the Pipe-in-Pipe, ITP and JP Kenny (UK pipeline engineering company), worked together as an integrated team. While JPK was carrying out the overall pipeline design, ITP performed the detail thermal and mechanical design of the Pipe-in-Pipe, especially the field joints. This work was cross-checked by JP Kenny using their in-house methodology, which at the end provided a very safe design approach. In parallel, the operator also imposed Third Party verification by an international certification agency on all the Contractors involved. This independent verification actually covered both the design and the fabrication of the Pipe-in-Pipe double joints, held in a dedicated yard located in Northern France.

ONSHORE PIPE IN PIPE ASSEMBLY

Due to the tight planning it was important to use a logistically advantageous location for the pipe in pipe assembly in a well known environment to minimize contingencies.

The Dunkirk pipe in pipe yard, that was selected to assemble the FORVIE pipe in pipes, had two main advantages :

- the logistics due to :
    - its location on the North Sea,
    - a rail access that allowed to deliver the linepipe directly into the PiP yard. Pipes came from France (V&M tubes) and Germany (Mannesmann linepipe)
    - a deep-draft dock. Assembled pipe in pipes were offloaded on cargo barges to be shipped the Shetland Islands.
- the fabrication experience gained during Shell Bonga project. 37km of PiP were fabricated there for a deep water application

Fig 8: Geographical location of the pipe in pipe yard & deep draft harbour

ITP implemented the exact same double joint fabrication process to comply with the FORVIE planning except for the double joint welding operations, which represented a major change. Indeed, an automatic welding process (GMAW 5G process) was set up to perform the double jointing welding activities (buttwelds) of the 34mm thick 15'' inner pipes (X65 carbon steel) that were delivered in 8m lengths to finally obtain 24m joints. A lesson learnt from the project is that heavy wall pipeline automatic welding requires high level welders, even onshore, to improve the learning curve at production start up.

By replicating a well known fabrication process, minimizing handling of pipes for safety reasons as well as for logistics-schedule issues (each Pipe-in-Pipe double joint weighed about 11 tonnes), the anticipated production rates were achieved to provide 24 PiP double joints in a single shift (585m/day) with a peak production at 26 double joints and the overall production in Dunkirk lasted 88 days.

OFFSHORE INSTALLATION PHASE

The selected pipelay contractor was ALLSEAS, with its Solitaire vessel. Although the pipe to be welded offshore was very thick, ALLSEAS was able to achieve a high lay rate due to the welding experience of Allseas combined with the ITP-specific field jointing technique for Pipe-in-Pipe. Indeed the lay rates of this heavy wall pipe in pipe achieved up to 2.9km a day (24 hours).

Fig 9: The Allseas Solitaire approaching North Alwyn B platform

The Offshore installation campaign started only 2 weeks after the end of the fabrication of the last double joint in Dunkirk and was successfully completed in August, 2005 after a productive laying campaign.

Fig 10: Pipe-in-Pipe field joint entering the overbend region

CONCLUSIONS

By engineering, fabricating and delivering the 33km of pipe in pipe on time (one year after contract award) and on budget, ITP proved its capacity to participate to the successful fast track project.

The FORVIE pipe in pipe project with a field proven design and a well managed procedure allowed ITP to handle in parallel another challenging project in deep water Angola (1470m) for which technical & local content challenges needed to be addressed carefully.

2005-06 will mark an important milestone for ITP since the resulting 66km pipe in pipe laid in Angola, as well as the 33km of the Forvie pipe in pipe, provide to date the best thermal performance in their respective geographical regions (namely Gulf of Guinea and North Sea sector).

By directly supervising the activities of key contractors and making technical choices, operators can manage fast track projects with success outside of a typical EPC framework. By following this project architecture TOTAL could start up the Forvie field just before New

Year's Eve 2005, meeting the planned schedule, once the other offshore tie-in activities were done.

ACKNOWLEDGEMENTS

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