

Operators develop two-of-a-kind in Angola

New subsea equipment is heading for BP's Greater Plutonio and Total's Pazflor projects.

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During the past 10 years, most players in the oil and gas industry have worked to establish and grow their Angolan operations. The task has been unlike developing any other site in the world. The country's 30-year civil war, which ended in 2002, resulted in a lack of almost every resource — from manpower to raw materials to finance. Angolan operations have relied on support from sites and employees around the world.

Despite this challenge, FMC is working to increasing the amount of local content and the number of local employees in Angola. Investing in employees involves a strategy built on health, safety, and environment principles; quality assurance; local skills development programs; and a long-term vision. As a result, FMC Angola is investing heavily in employee training and development programs.

2.1 MMb/d of oil.

With its main operation based in the Sonangol Integrated Logistics Services oilfield service center in Luanda, FMC Technologies' Angola division has grown to be a significant and economically important part of the company's global operation. The growth of the operation comes at a time when Angola's deepwater fields are recognized as one of the most exciting hydrocarbon reservoir sinks in the world.

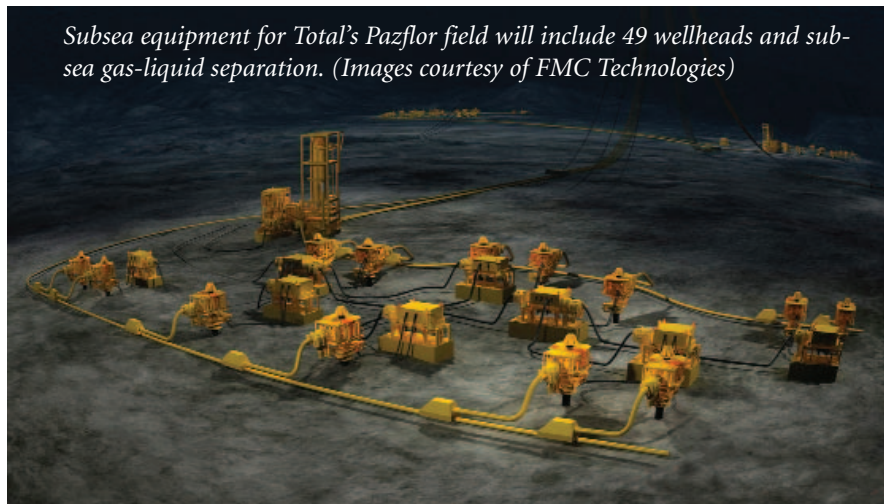
Around the blocks

Two major contracts have defined the success of FMC in Angola — BP's Greater Plutonio and Total's Pazflor.

As one of the largest projects executed by FMC, Greater Plutonio (Block 18) has been more than just a financial success. The initial contract was valued at approximately US \$270 million in revenue when awarded by BP in mid-2004. It has grown considerably as a result of design changes and the need for additional equipment and spare parts. Most significantly, Greater Plutonio established FMC Angola's capability to successfully support a project through local manufacturing and service.

development of five fields: Galio, Cromio, Paladio, Plutonio, and Cobalto. A spread-moored floating production, storage, and offloading (FPSO) vessel located southeast of Paladio will process fluids produced from the subsea production wells. A single flowline will accommodate production from the northern system (Galio, Cromio, and Paladio), and a looped flowline system will accommodate production from the southern system (Cobalto and Plutonio).

Subsea equipment for Total's Pazflor field will include 49 wellheads and sub-sea gas-liquid separation. (Images courtesy of FMC Technologies)



The project is achieving some significant firsts in Angola. In addition to the production of six manifolds and 42 permanent guide bases at local suppliers, 25 subsea trees have been assembled locally at the Luanda base.

Management, fabrication, assembly, and offshore service assistance also are localized in Luanda. A 15,069-sq ft (1,400-sq-m) pipe work fabrication hall in Lobito was built for the purpose of executing manifold manufacturing contracts.

Greater Plutonio

The Greater Plutonio project comprises

Manifolds will be offline from the flowlines and connected via tie-in spools to inline tree assemblies. Water injection will be used to provide reservoir pressure maintenance. Injection water will be transported by a single flowline for the northern system and by two flowlines for the southern system.

In addition to the trees, the entire project comprises associated structures, manifolds, well jumpers, and production control systems as well as connection systems for flowlines and umbilicals. FMC also has supplied technical services related to installation and start-up and

Production from five fields will flow through two flowlines to an FPSO on BP's Greater Plutonio project.

has a life-of-field agreement included in the contract.

Pazflor

They don't come much bigger than Pazflor, which lies in Block 17, approximately 25 miles (40 km) east of the existing *Dalia* FPSO and 93 miles (150 km) from shore. This project launches a major new stage of development in West Africa, as there is no analogous well using the same subsea processing nearby. The Pazflor project represents a global industry first, with FMC providing seabed gas and liquid separation.

Using technology to separate gas and liquid at the seabed eliminates gas lift and allows more stabilized flow in the risers, enabling Total to produce heavy oil. Gas lines from the subsea separation units will simplify the overall hydrate prevention strategy since the subsea system can be depressurized in the event of an unplanned shutdown.

The project targets development of hydrocarbons in two independent reservoir structures: Miocene reservoirs in 1,968 to 2,953 ft (600 to 900 m) water depth, containing heavy oil to be recovered using subsea gas/liquid separation and liquid boosting; and Oligocene reservoirs in 3,281 to 3,937 ft (1,000 to 1,200 m) water depth, containing light oil to be developed with a production loop including riser bottom gas lift.

The overall development currently consists of 49 subsea wells connected via subsea production, injection lines, and risers to a spread-moored FPSO. The topside control system is designed to accommodate an additional 21 wells and a fourth subsea separation unit. The company also will deliver three subsea separation systems.

The 49 trees include 25 production trees, 22 water-injection trees, and two gas-injection trees. FMC also will supply 49 wellhead systems for the project in addition to three four-slot production manifold systems, a production control and umbilical distribution system, gas export and flowline connection systems, ROV tooling, and local support for installation and start-up activities. The subsea wells will be connected via



subsea production and injection lines and risers to the FPSO.

Although the subsea processing trend is becoming more and more of a standard solution in the oil and gas industry, Total's Pazflor project uses major technology advances and represents a world technology first for two-phase separation and liquid boosting at the mud line, the scale of the development, hybrid pumps technology, and vertical separator technology.

Improving efficiency

Through the BP work, Angola has proven that it can meet exacting quality standards. The real challenge in the country is not quality; it is efficiency. Because costs in Angola are greater than in Dunfermline, Scotland, FMC Angola is looking to introduce Lean manufacturing principles, beginning with the assembly process for subsea trees.

FMC Angola plans to produce up to

four trees/month as it executes the Pazflor contract. With BP fabrication now complete in Angola, there will be capacity to develop 12 work cells dedicated to the Pazflor project. In 2010, Dunfermline will supply the Angola operation with 24 tree kits which will then be assembled in Angola.

Subsea control modules are manufactured in Kongsberg, Norway, but final testing is now performed in Angola. Initially, FMC Angola conducted only basic testing, but this has evolved to include advanced testing, maintenance, and repair of major components as well as work with electronic systems.

FMC's operation in Angola has experienced rapid growth in a short time. There is tremendous opportunity for future growth as well. The FMC vision for Angola is expected to support the company's growth in that region in the coming years and will serve as a model for entry into other operations around the world. **F&P**