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THE WORLDS FIRST ELECTRIC MANIFOLD RETROFIT PROJECT

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Abstract

Statoil will install an electric actuator upgrade kit to convert 3 manifolds for electric operation of choke and branch valve functions in a campaign the summer of 2006.

A description of the functionality of the system will be given, with Statoil's perspective on the objectives for performing the project.

The qualification program and results will be presented and finally, an update on the installation experience will be given.

1. Introduction

Electric actuator systems are a new technology for operation of subsea valves. The only real field application in operation today is the choke system developed by FMC Technologies and installed in 2002 on Statoil's Statfjord satellite project where 16 choke actuators are controlled by electric actuators.

The technology offers precise position control and can be applied subsea without hydraulic umbilical, providing a huge cost saving potential. Basing the system on local energy storage with rechargeable batteries enables cost efficient retrofit scenarios like the Norne system where manual and hydraulically operated valves and chokes now will be electrically operated. This modification gives better response times for the chokes, enables free routing of existing and new infield wells and it liberates hydraulic lines in an existing umbilical. The lines in the umbilical will now be used for chemical injection fluids, so the need for a new umbilical for the new wells was eliminated and CAPEX for the field extension was reduced significantly.

It is generally accepted that electric actuator systems will be installed in a high number of subsea production fields. Particular long step out projects in environmental sensitive areas will benefit from this low power clean technology. Also subsea process systems use electric actuators for flow control valves and fast acting anti surge valves. As a key enabling technology for precise and reliable flow control in such installations the subsea electric actuator system will have a broad interest in the subsea community.

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The design of the actuator with in-service retrievable components will have a significant impact on system availability for subsea production and processing systems. The ability to retrofit existing fields with new technology to reduce cost of field expansion and improve production control can revitalize and extend production from mature fields, as well as provide a cleaner more modular control system for future developments.

The first commercial order for the system was awarded in May 2005 by Statoil for its Norne Improved Oil Recovery (IOR) project. A total of 21 electric actuators and 6 electric control modules will be installed. Figure 1 indicates the field layout and the location of the electric actuators.

2. System Description

The system consists of electric control modules and electric actuators connected with an electric harness terminated with traditional 12 pin wet mate ROV connectors. The way the system is laid out, it has a plug-and-play architecture for easy configuration. Up to 16 actuators of different types can be connected to the harness. The system is easy to configure for different manifold configurations and xmas trees using the same building-blocks. The actuators are powered from rechargeable batteries in the control modules and run on 24 V DC. Figure 2 indicates the different building-blocks configured for a manifold and a xmas tree.

2.1. Electric control module

The electric control module, the eSCM, contains the traditional Subsea Electric Module functions for communication modems, power supplies, I/O and CPU. In addition, functionality is added for power switching and a complete Li-Ion battery management system with battery cells and associated protection circuitry, charging and current monitoring functions. The eSCM is installed in a simple funnel without running tools and is much smaller than a traditional SCM.

2.2. Electric actuators

The electric actuators consist of brushless DC motors with planetary gearboxes in oil-filled pressure compensated housing. Integral with the actuators are the servo-controllers for the motors in 1 atm. chambers to obtain a distributed control architecture, each individual actuator have its own intelligent motor control, and only high level commands are sent over the control lines and all diagnostics and low level control takes place in the actuator itself. This feature makes the system more robust and flexible. The actuators exist with two different motor sizes. This model range and a large selection of gear ratios for the planetary gear reducers provide a full range of torque capabilities for typical subsea manifold and xmas tree configurations. A fail safe version is realized with an integral battery pack to store energy locally in electro-chemical form compared to potential mechanical energy in compressed springs. The actuators are mounted to the valves using the ROV override interface, and as such can easily be adapted to any company specific valve override interface.

3. Norne System Implementation

Statoil is very active in deploying new technology to improve production and recovery rate from mature subsea fields in the North Sea. Norne is one of these mature fields where one expect to extend the field's production life from ending in 2016, to beyond 2020 by different IOR methods. Infield drilling is one of the methods used, and a new production template is installed for the new wells. The main motivation for introducing electric actuators to this field was to liberate umbilical lines for chemical injection to the new production template. To achieve this, a previously direct operated hydraulic pig-loop valve was converted to electric actuation, and the lines previously used for control fluid could be redirected to the new template supplying chemical injection fluids.

When Statoil had taken this initial step for electric technology it was relatively easy to expand the system to include electric control of chokes and branch valves using the same eSCM's and just build a different harness to connect the additional actuators.

The choke actuators will improve response time dramatically, since the existing Electro-Hydraulic system suffers from very slow response times, and well shut-in could take as much as 45 minutes. With the electric technology this is reduced to less than minute for each choke.

In addition, it was decided to also convert the branch valves to electric remote control. The objective was to obtain the capability of free routing of the individual wells on the manifold. This is an important feature when new wells are routed into existing manifolds and commingled with mature wells. The need for matching the operating pressures will require frequent re-routing of the wells which can only be achieved in a practical manner using remote controlled electric actuators.

Finally, Statoil wanted to use the opportunity to accumulate field experience with the fail safe version of the electrical actuator, and decided to install two of them on the manifold. The motivation for this choice is to prepare for future use as part of the fail safe system on xmas tree valves.

To summarize, the Norne installation will be a full-scale field qualification of a complete new system for electric actuators capable of both manifold, choke and tree applications.

4. Technology qualification

A technology qualification program was prepared for the project in order to meet Statoil's requirements, which to a large extent follow the ISO 13628-6 Standard for subsea equipment. The test program was divided into prototype testing, qualification testing and production testing. The objective of the test and qualification program was to subject the new products to realistic loads and duty-cycles in a staged manner to enable relatively rapid prototype debugging and verification, as well as comply to formally and rigorous test regimes defined by Company requirements and International Standards. A brief description of the testing in the different phases is described below.

4.1. Prototype testing

The Full functional testing and endurance testing was performed to the prototypes. Prototype testing is carried out to ensure proper function of the products. The endurance testing is performed to uncover potential failure modes and marginal designs.

The new Li-Ion battery systems were subjected to full life cycle testing before the prototype development of the products to ensure that such a vital part of the overall system design was performing as expected. This test program was completed with excellent results and after inspection of the battery cells, no sign of degradation was detected.

4.2. Qualification testing

The qualification testing is performed to formally demonstrate that the performances of the products are in compliance with the defined requirements set forth in i.e. ISO 13628-6. The qualification testing consists of shock and vibration testing to individual circuit-boards and assemblies containing circuit-boards.

Hyperbaric testing of components is performed to demonstrate pressure integrity and satisfactory function under relevant ambient conditions. Endurance testing to high cycle numbers under partial and full load is carried out to simulate typical life time duty and, if any, uncover component weaknesses.
Full functionality shall be demonstrated for the products similar to the prototype testing mentioned above.

4.3. Production testing

The testing of the final products is performed to detect malfunctions prior to shipment to clients. The production units go through Environmental Stress Screening, ESS, with temperature cycling, vibration exposure and burn-in of circuit boards. Assembled units are then functionally tested in hyperbaric chambers.

5. Installation

The installation of all the equipment will be performed from a light vessel by means of ROV and lift wire. The plan for installation is an open issue at the time of writing (end June 2006), but will be carried out when the marine operational schedule have openings from early fall 2006. Previous experience from the Statfjord project indicates that very short installation times can be expected.

6. Figures

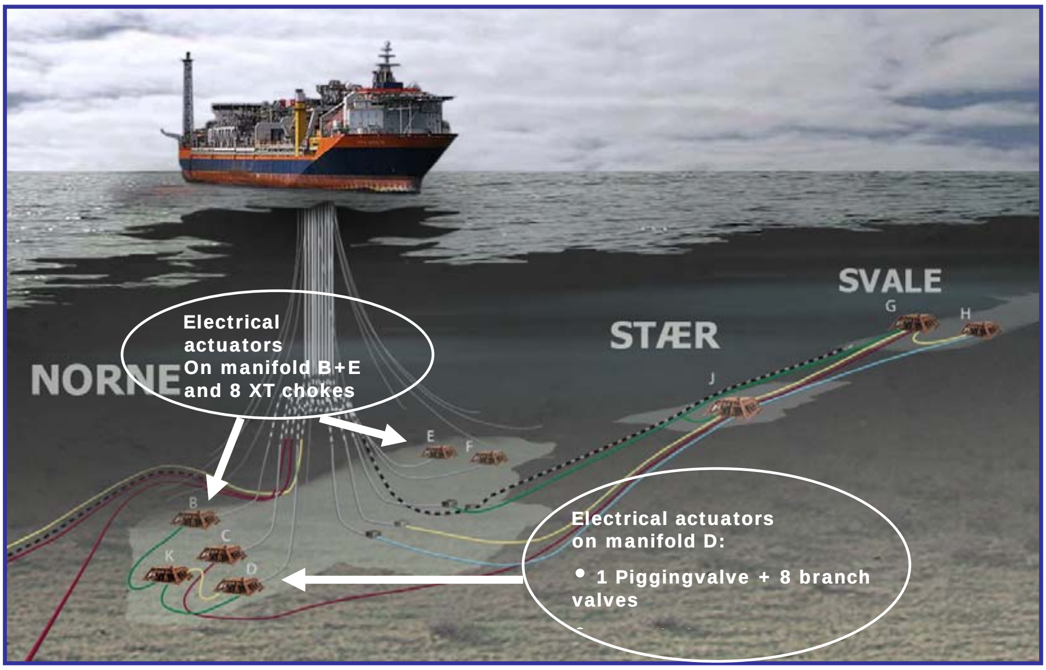

Figure 1. Norne Field layout with electric actuators

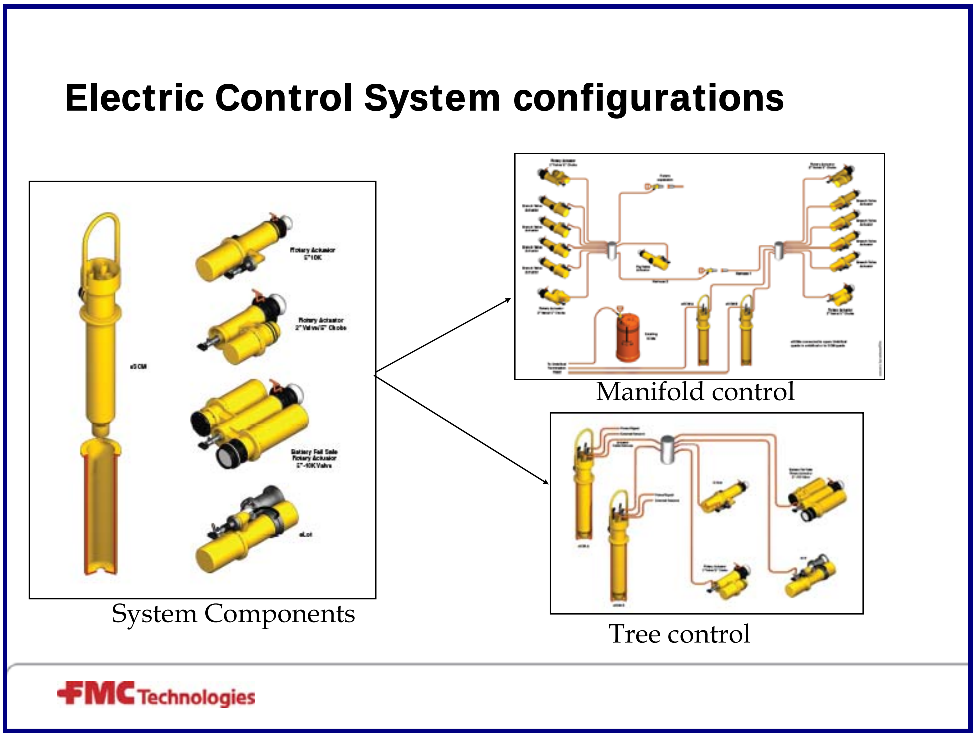

Figure 2. Electric control system building blocks

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