North West Shelf Approached to Well & Asset Integrity
Integrity

• “The state of being whole, entire, or undiminished.” [1]
• “A Sound, unimpaired or perfect condition.” [1]

“Subsea system is qualified for field life so why do I need monitoring?”

Subsea Integrity

- How to approach integrity requirements?
- Typical types of integrity methods?
- Examples of CWOR Integrity System
- Examples of Life of Field integrity systems
- The importance of Data.
System Integrity

**Flow Assurance and Process Simulations**

- **Tender, Concept Evaluations**
- **FEED**
- **Detailed Engineering**
- **Installation & Commissioning**
- **Operation (Life of Field)**

**Flow Assurance and Process Simulations**

- Optimize field architecture
- Subsea processing evaluations
- Fluid characterization / Flowline sizing / Equipment selection / verification;
  - Pressure drop calculations;
  - Operating envelope
- **Thermal design & assessment**
- **Erosion allowance estimation**
- **Flow-induced vibrations**
  - Ad-hoc studies – Riser Monitoring, choke performance, blowdown, CFD, etc.
- JT / Min / Max exposure temperature
- Uptime and production optimization

**Safety Integrity Systems for CWOR (PSD, EQD, ESD)**

**Watch Surveillance**
- CPM
- VFMS

**Riser Monitoring System (WAMS)**
- Analysis
Typical Project - Evaluation

**Tender, Concept Evaluations**
- Flowline and equipment sizing
- Optimization of field architecture
- Evaluate artificial lift & subsea processing requirements

**FEED**
- Field layout optimisation
- Thermal analysis and design
- Max/min temperatures
- Sand erosion analysis
- Chemical injection system sizing
- Flow induced vibration screening
- Choke sizing

**Detailed Engineering**
- Hardware optimisation
- Thermal design verification and optimization
- Flow induced vibration analysis
- Verification of erosion potential
- Procedures

**Installation & Completions**
- WH integrity monitoring
- Riser & CWOR integrity monitoring
- Subsea XT integrity
- WOCS integrity hardware

**Operation Life of Field**
- Real-time production allocation
- Virtual flow metering
- Real-time production planning and optimization advice
- Condition and performance monitoring
System Integrity – Tender & Feed

- Tender, Concept Evaluations
- FEED
- Detailed Engineering

Flow Assurance and Process Simulations

- Thermal design & assessment
- Erosion allowance estimation
- Flow-induced vibrations
- Ad-hoc studies – Riser Monitoring, choke performance
- Flow Assurance and Process Simulations
- FIV screening
- FIV analysis (FSI)
- Erosion allowance estimate (1D)
- Detailed CFD analysis (3D)
- Insulation design and thickness (1D)
- Cooldown analysis (3D)
- Cold spot identification / mitigation
- JT / Min / Max exposure temperature

- Fluid characterization / Flowline sizing / Equipment selection / verification;
  Pressure drop calculations; Operating envelope

- Subsea processing evaluations

- Optimize field architecture

- Uptime and production optimization
- Ad-hoc studies – Riser Monitoring, choke performance

- Safety Integrity Systems for CWOR (PSD, EQD, ESD)
- Riser Monitoring System (WAMS) - Analysis
- System Integrity – Tender & Feed
Installation & Completion Integrity

Well Access Monitoring
Installation & Commissioning

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Safety Integrity Systems for CWOR (PSD, EQD, ESD)

Riser Monitoring System (WAMS) - Analysis

Uptime and production optimization
- Watch Surveillance
  - CPM
  - VFMS
Typical Workover Packages
Australia/North West Shelf
Operating Conditions

Standard operating conditions to manage:

• Heave
• Rig movements
• Number of Connections
• Vortex Induce Vibration (VIV)

How does this affect:

• Riser (Standard & Specialty Joints)
• EDP/LRP
• Subsea Tree
• Wellhead

How to ensure the optimum condition and performance of hardware?
Well Access Monitoring
Well Access Management System

• Ensures system integrity during offshore operations
• Optimizing safety and cost-efficiency for operations
• Monitoring actual loads for input to maintenance
• Real time logging of data with offline analysis of data
• Proposed development of service data base to keep track of utilization and fatigue life of riser components
Well Access Management System

Operating Limitations
- Offset: 20
- Limiting component: 12.5/5.5 KV ST adapter
- Criterion: Structural
- Utilization: 0.45

Lower Stack Loads
- Load: 30 kN
- Total: 120 kN
- 150 kN

Alarms
- AN: 
- STRUCTURAL: 
- PRELOAD: 
- SEPARATION: 
- REPO: 

Selection
- Type: Surface Flow Tree
- PN: P/2000012118
- EN: 1119481
- SN: 4724806-00800-1
- Status: OK
- History: Operations, Maintenance
- View Inspection Procedures

Overview
  - Days: 29
  - Status: 
  - Cost: $... $... $... $...
Sensor on Tension Joint

- LTSJ
- EDP
- LRP
Sensors and Inclinometer on Lower Stress Joint
Inclinometer and communication module on EDP
Sensor Package on LRP
Operational Integrity (Life Of Field)

Condition and Performance Monitoring
and Flow Management Technologies
System Integrity

Tender, Concept Evaluations → FEED → Detailed Engineering → Installation & Commissioning (Life of Field)

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Subsea processing evaluations
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Detailed CFD analysis (3D)
- Safety Integrity Systems for CWOR (PSD, EQD, ESD)
- Riser Monitoring System (WAMS) - Analysis

Operation
- Watch Surveillance
  - CPM
  - VFMS

Uptime and production optimization
Condition Performance Monitoring

- System Integrity Management
- Early Warning
- Better Service
- Easy Fault Finding
- Better Design
- Increased Availability

- Part of subsea services organization
- Focus on performance of subsea production system
- Established in Asker, Norway, in 1990’s
- >100 employees with offices in Asker, Singapore, Houston and Rio
CPM

Data collection

Calculation, Simulation and Analysis

Collaboration and Support

- Sensors
- Actuators
- Chokes
- Power and Communications
- Hydraulics
- MPFM

FMC operation room

Client operation room
CPM

DATA COLLECTION

SPCU / TPU

Reduction of data traffic !!!

SURVEILLANCE DATA

Topside Control System

OPC

MAINTENANCE INTEGRITY MONITORING

CPM

NON OPERATION-CRITICAL DATA
CALCULATION, SIMULATION AND ANALYSIS

CPM

FMC and client

FMC

AGGREGATION

TCI%

TCI%

TCI%

TCI%

TCI%

TCI%

TCI%

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Operational Integrity (Life Of Field)

FLOW MANAGER
Flow Manager

A multiphase flow simulator for online surveillance, optimization and prediction of subsea oil and gas production.
Leakage and Blockage Detection

- Objective - Use all relevant field measurements to detect a leakage in the pipeline
- Early warning tool for the operators
- System combines information from sensors, FlowManager™ calculations of pressures and flow rates and statistical process control (SPC) methods

NB: Can also detect blockages
Leakage detection – SPC methods

- Pressures and flow rates monitored using SPC methods
- Shewhart control chart - Rapidly detects larger leakages while smaller leaks will be ‘hidden’ in the measurement noise

Example: Detection of changes in difference between calculated and measured flow rate
Leakage detection – SPC methods

- **Cumulative sum (CUSUM)** - Detects smaller leaks by integrating the leakages information over time

Example: Detection of changes in difference between between calculated and measured flow rate

- Alarm raised if one of the SPC methods detect an indicator outside its limits
- Limits for the two SPC methods are based on the standard deviation of the indicators monitored
- Limits are tunable -> impact on LDS sensitivity
Leakage detection – Leak location

- The leakage location is found as the intersection between two pipeline pressure profiles which are calculated based on inlet and outlet measurements respectively.

\[
\begin{align*}
\text{Pressure} & \quad \text{Pipeline Distance} \\
P_1, T_1, Q_1 & \quad P_2, T_2, Q_2
\end{align*}
\]
Conclusions

What Does It All Mean?
CONCLUSIONS

1. FMC Technologies sees integrity as a fundamental to the system design, and begins at Tender and FEED stages.
   – Continues all the way through the Life of Field, and even to P&A.
2. There are many integrity management tools available in the market today. All present value to the operator, and industry.
3. WAMS – Not only presents value in monitoring the current condition of the hardware, but creates value in asset management.
4. CPM – Life of Field integrity management tool. Provides essential data on the condition and performance of hardware.
NWS approach to Integrity Management

Data
- is the new O&G market
- has significant value to operators

Operators are looking outside of the O&G industry to process the data

EPC companies have developed tools that monitor field integrity, generating valuable data

Developing the data creates a huge potential to the O&G industry.
Questions?
We put you first.
And keep you ahead.