Condition & Performance Monitoring - The Future of Subsea Operations

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Presentation lay-out

1. Subsea development
   - past and current state of the art
2. Predictive & proactive maintenance
   - new operation philosophy
3. Subsea system monitoring technology
   - novice to intelligent
4. Preventive maintenance in practice
   - AI Card failure in a Subsea Control Module
5. Summary
   - CPM main advantages
Reactive to Proactive Maintenance

• Industry drivers:
  → Increased SIOR
  → Reduced maintenance costs
  → Integrated Operations
  → Improved HSE
  → Inaccessible environments
  → Environmentally sensitive areas
What is new when going subsea?

- Large amount of data from the subsea system is never or seldom used
- Topside control system focus on production control and safety
- Less than half of available subsea data is used on a continuous basis
- Data not required for the topside control system is lost
- Housekeeping and system data require in-depth knowledge of subsea installation and control system
Reactive to Proactive Maintenance

- Reactive
- Planned
- Proactive
- KPI trending
- TCI surveillance
- Collaboration
- Single sensor trending
- Don’t fix

Operational excellence vs. Novice to intelligent
Technical Condition Index

Enabling technology encapsulating expert knowledge, system criticality and operational and maintenance philosophy in CPM.

✓ TCI
  - Trending of technical condition index. TCI can be as simple as a single sensor or as complex as a virtual sensor, erosion model, mass balance, pump efficiency etc.
  - Ranging from 0-100, 100 indicating performance as designed
  - Assigned weights according to criticality in the system

✓ Logical hierarchic model of subsea production facility
  - Each node in tree assigned one or more TCI’s
  - Modeling dependencies between TCI’s
  - Prediction of impact of reduced integrity from lower levels on parent levels

✓ Aggregation rules
  - Defining how each TCI on a particular level impacts TCI on next level
  - Weighted sums, worst case scenarios, penalty function, fuzzy logic, user defined
Proactive Maintenance
Added Value Benefits

- SCM change-out
  - Unplanned intervention 1-7 days
  - Planned intervention 6-8 hours

Total added value by CPM ranging from 1.6 to 12.8 MUSD/well/yr
Condition and Performance Monitoring
A holistic approach to subsea integrity monitoring

✓ Early warning of reduced integrity and efficiency
  • Maximize production capacity
  • Improve system availability
  • Prevent unplanned shutdowns
  • More efficient interventions

✓ Collaborative diagnosis and problem solving
  • Encapsulate expert knowledge in the system
  • Address demographics and “brain drain”
  • Access to internal and external expert network

✓ Complete and extensive historian database
  • More efficient trouble shooting
  • Analyze past incidents
  • Recalculation of integrity parameters (what if simulations)

✓ Improved HSE records
  • Minimize environmental impact
  • Minimize operational surprises
  • Onshore support (less traveling of personnel)
  • Better planning of maintenance campaigns