ExxonMobil – Capturing Deepwater Experience to Improve Subsea Reliability

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Presentation Outline

• ExxonMobil Deepwater History & Trends
• ExxonMobil Project Highlights/Outlook
• Deepwater Development Characteristics
• Lessons Learned – Examples
  – Subsea Wet Insulation
  – Hydraulic Flying Leads
• The Reliability Challenge
• Proactive Improvement Approach
• Conclusion
• Way Forward – Deepwater Reliability Improvements
ExxonMobil Offshore Technology - A Long Term Commitment

- Track record for offshore innovation
- Focus on fundamentals to ensure integrity and cost effectiveness
- Ability to apply research and add value to deepwater developments
ExxonMobil’s Move to Deeper Water

- Grand Isle-GOM 50 ft
- West Delta-GOM 168 ft
- Hondo CA 850 ft
- Lena GOM 1000 ft
- Harmony CA 1200 ft
- Zinc-SS GOM 1480 ft
- Hoover/Diana-GOM 4800 ft
- Marshall Madison-GOM 4850 ft
- Angola Kizomba-A 3900 ft FPSO/SS
- Angola Kizomba-B 3600 ft FPSO/TLP
- Angola Kizomba-C 2400 ft FPSO/SS
- Nigerian Erha 3600 ft FPSO/SS
- Angola Xikomba 4450 ft EPS-FPSO/SS
- Mica-GOM 4350 ft SS
- FPSO
- TLP
ExxonMobil Deepwater Business Trends

• Subsea portfolio is expected to double within the next 5 years – primarily driven by developments in West Africa
• Increasing contribution from subsea volumes, primarily deepwater
• Field locations remote from infrastructure, operating requirements more demanding, more challenging fluids/reservoirs
• High rate wells, significant volumes increasing need for reliability focus
• Project execution in high activity environment
Deepwater Development Characteristics

• Typically contains highly engineered equipment, numerous sub suppliers, frequently an industry step-out, or first application of technology
• High cost/consequence failures – equipment typically designed for 20+ years of flawless service
  – Qualification for service is critical, assessments required for each project
  – Vendors interpretation of qualified/field proven subject to Operators interpretation
• Industry standards do NOT cover majority of components, Company specs, engineering judgment used to bridge gap
• Deepwater developments are still a relatively frontier area – less than a decade of operating experience. Exposed to catastrophic problems/failures through unforeseen technical issues.
• Vendors routinely optimizing designs to improve product lines
  – Supply chain management, new supplier approval - reevaluation of design impacts needed
  – Heated market, managing impact of limited technical resources and experience
  – Frequently design nuances determined post-award, additional qualification needed during project execution
• Operating experience, lessons need to be captured to avoid repeats
Wet Insulation Failures

- Insulation critical to capture heat, manage hydrates, wax in deepwater
- Failure modes (cracks, disbondment, etc.) greatly affect thermal performance
- Causes identified
  - Lack of surface preparation
  - Out of spec. mixing ratios
  - Improper material use – not qualified for service
  - Lack of understanding of in-service condition behavior
  - Limited qualification testing
  - Improper design, field joints, connection details
Hydraulic Flying Lead (HFL) Failures

• Hydraulic flying leads essential to operation (hydraulic supply, chemicals)
• Numerous HFL failures experienced related to fitting leaks, hose bursts
  – End fitting seal surface damage, excessive torque during fabrication, fittings assembled incorrectly
  – Poor / missed carcass welds prior to the Nylon extrusion process
  – Carcasses insufficiently threaded into the hose coupling

• Hockling (twisting under pressure) compromises HFLs minimum bend
  – Hockling torque in excess of 1225 Nm (900 lbf-ft) damaging stab plates, tubing, couplers
  – Extensive investigation, product re-design and quality improvement required with HFL suppliers
The Reliability Challenge

• Scope of qualification testing needs to be well-defined, ahead of contract award, to ensure subsea equipment performs reliably under expected project service conditions.
  – Basis for vendor declaration that equipment “qualified or field proven” needs to be
    • Clearly documented
    • Readily available for review and acceptance.
  – Alignment needed on acceptable qualification testing standards, methods
• Qualification process needs to consistently flag critical design features or inherent weaknesses, to ensure adequate evaluation.
  – Need to be failure mode based
• Qualification needs to be integrated with QA/QC
  – Tighter acceptance testing for critical features
• Relate equipment failures/lessons learnt to effectiveness of qualification, QA/QC practices
• Provide a mechanism to effectively, clearly communicate functional requirements and potential failure mechanisms with vendors and their growing supply chain, particularly second and third tier suppliers.
Proactive Reliability Improvement Approach

- EM in conjunction with major subsea vendors have developed a systematic, structured approach to subsea equipment qualification
  - **Generic failure mode assessment (FMA) templates developed at component level** for subsea system equipment
    - FMA based approach - based on simplified DNV-RP-A203 and FMA methods
  - Utilizes a **datasheet format, referenced directly to vendor part number** (similar to ISA Datasheets used in topsides)
    - Documents service conditions, also qualification testing for failure modes, basis for acceptance
    - Documents QA/QC criticality for the specific part number
    - Summarizes FAT requirements
    - References reports, standards, supporting info
    - Provides historical qualification information
  - Part number, datasheet approach improves visibility on technical information, facilitates standardization, procurement

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### Levels of Technical Definition

- **Part Numbers**
- **Specific Designs**
- **Defined Interfaces**
- **Equipment Specifications**
- **Functional Requirements**

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### Scope of Standardization

- **Integrated Systems**
- **Systems**
- **Assemblies**
- **Sub-assemblies**
  - **Components**
  - **Sub-components**
  - **Machined parts**
  - **Materials / Forgings**

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**ExxonMobil Development**
Subsea Component Qualification Categories

- 11 identified Component Categories
- 75 components identified based upon criticality
- Criticality based upon hydrocarbon containing, failure resulting in PSD or subsea intervention, failure resulting in loss of primary operations functionality

- Valves
  - Ball
  - Gate, etc...
- Actuators
- Chokes
- Subsea tree assembly
  - Main body
  - Tubing hanger assembly
  - Tree cap, etc...
- Manifold assembly
  - Fittings (tees, crosses, elbows)
  - Pipe bends
  - Pigging assembly, etc...
- Jumpers and Connectors
- Subsea controls – hydraulic/chemical
  - Couplers
  - Hydraulic flying leads
  - SCM-hydraulics, etc...
- Subsea controls - electric
  - Transducers
  - Electrical flying leads
  - Flow meters, etc...
- Coatings and insulation
  - CP system
  - Preservation fluids
- Completion equipment
- ROV tools and installation aids
**Product Qualification Sheets (PQS) - Example**

**Component Identification Information**
- Component / assembly type & description
- Vendor / sub-supplier(s)
- Part # & BoM
- Drawing # & assembly procedure #

**Service Conditions / Operating Parameters**
- Water depth
- Operating pressures / temperatures
- Material class / requirements
- Design life, etc.

**Preferred Configurations / Characteristics**
- Optional equipment selection
- Location / orientation of elements
- Preferred coatings
- Labeling / markings, etc.

**Qualification Testing Requirements**
- Qualification testing requirements
- Applicable industry standards / codes
- Acceptance requirements
- Performance verification

**Quality Requirements / Inspections**
- Inspection & testing requirements (FAT, SIT, SRT)
- Dimensional verification requirements
- Documentation requirements
- Material identification / traceability
**Conclusion**

Proposed process provides a proactive approach to improve subsea equipment reliability

- Generic failure mode templates highlight critical design features consistently
- Clear documentation of basis for fit-for-service acceptance
- Provides a starting point for management of design changes, upgrades to new service conditions, qualification gaps
- Part number basis fits well with vendor internal tracking systems, interfaces with manufacturing and quality systems – no need to invent something new
- Facilitates leveraging qualification information across many projects, operators
- Failure mode templates facilitate permanent capture of lessons learned
- Excellent reference tool for less experienced personnel, industry information capture

Other Opportunities

- Facilitates tendering, bid evaluation, project execution – promotes standardization
  - Vendor resources, project team can focus more on project specific issues
- Potential to minimize engineering costs, reduce contingencies, maximize vendor efficiencies
- Potential delivery schedule acceleration by capitalizing on existing successful designs
- Facilitates local content capabilities
Way Forward – Proactive Deepwater Reliability Improvements

• Ensure equipment can demonstrate performance across expected service conditions
  – Need consistent qualification processes
  – Higher visibility on fit-for-service basis
  – Structured process to manage design changes
  – EM proposal to API RP 17 Subcommittee – June ‘07
• Migrate toward standard components
  – Reliability through repetition of proven designs, interfaces
  – Minimize project specific engineering (tinkering)
  – Capture supply chain and manufacturing efficiencies, improved quality through repetition
• Facilitate successful vendor project execution
  – Streamline documentation, datasheet approach
  – Better communication with subvendors on critical information
• Improve permanent capture of lessons learned
  – Industry wide sharing via FMA approach
Questions?

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