



Latest Developments in Technology Qualification of HPHT Equipment

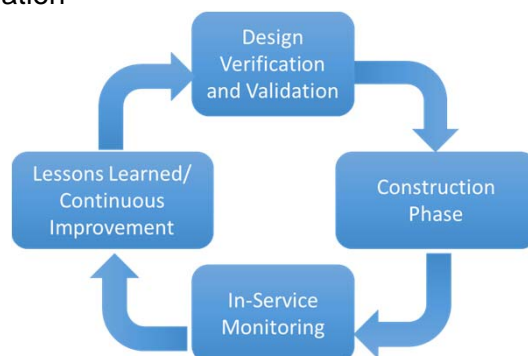
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Outline

- Introduction
- Overall Challenges
- ABS Technology Qualification Process
- Design Verification & Validation
- Status of Industry
- Summary
- Questions



Driver for Subsea HPHT

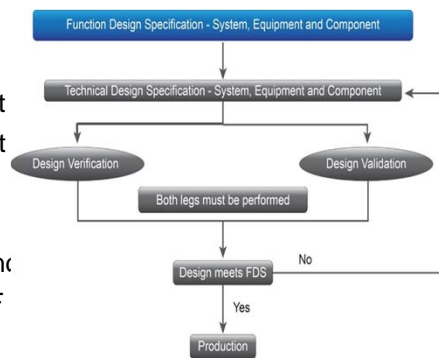
- Central GOM in US
 - Discovery with huge potential
- Anadarko, Chevron, BP, Shell in lead
- Pressure/temperature at well head exceed
 - 15,000 psi or 350 °F
- Discovery exceed available equipment capability
- Industry need solution

Overall Challenges

- HPHT conditions exceed capabilities of current drilling equipment
 - 15,000 psi and/or 250°F are current limitations
- Failure-mode thick-wall versus thin-wall
- Lack of codes, standards and/or regulations specific to HPHT system/equipment design and manufacturing
- Unknown risk associated with equipment design and operations
- Regulatory uncertainty and newly proposed regulations
- Lack of field data and industry experience

Introduction

- Definition of HPHT
 - HPHT is greater than 15,000 psi and/or greater than 350°F
- Code and standards for Well Control and Subsea Equipment
 - API Std. 53
 - API Spec. 16A – 4th Edition Draft
 - API Std. 16AR – First Edition Draft
 - API Spec. 16C – Second Edition
 - API Spec. 16D – Third Edition Draft
 - API RP 16Q – Second Edition Draft
 - API Spec. 6A
 - API 17 series document
 - ASME BPVC Section VIII, Div. 2 and
 - API Spec., 17E, 20E, 20B, and 20F
- HPHT equipment design process

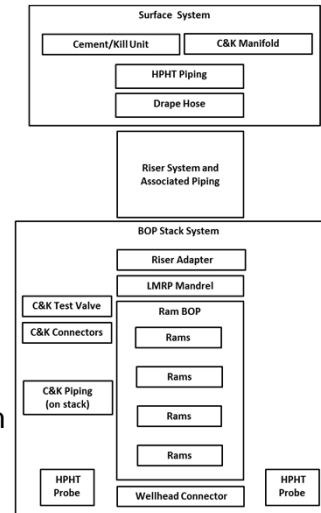


HPHT – US BSEE Requirements and I3P

- Follow US BSEE Draft – and 250 CFR:
 - Guidance on Obtaining BSEE Approval to Implement a High Pressure and/or High Temperature Project in the Conceptual and Final DWOP
 - Requirements for the design verification and validation, and material characterization
 - Independent third party requirements
- Operator/Owner to submit Design Verification, Validation and nominate Independent Third Party (I3P) with DWOP
- I3P to submit design verification and validation reports

HPHT Well Control Equipment Diagram

- BOP Stack System
 - Wellhead connector
 - Ram BOP/ram blocks
 - C&K connectors, valves, lines
 - HPHT probes
 - LMRP mandrel
 - Gas bleed valves
- Riser System
- Surface Equipment/Piping – C&K system
- Annular Preventer not HPHT



ABS

ABS Technology Qualification (TQ)

- Per API TR 17TR8 and API TR 1PER15K-1
 - **Qualification:** process of validation and verification of the technology against certain offshore and marine industry standards and practices
 - **Qualification** = Risk reduction through risk study:
HAZID/HAZOP/FMECA + Design Verification + Validation Testing
 - **Verification:** to confirm that HPHT equipment design or development activity is in compliance with its functional specifications and there is adequate protection against failure modes identified
 - **Validation:** to demonstrate that the equipment meets the mechanical integrity and functionality/operability requirements as per the functional/design specifications

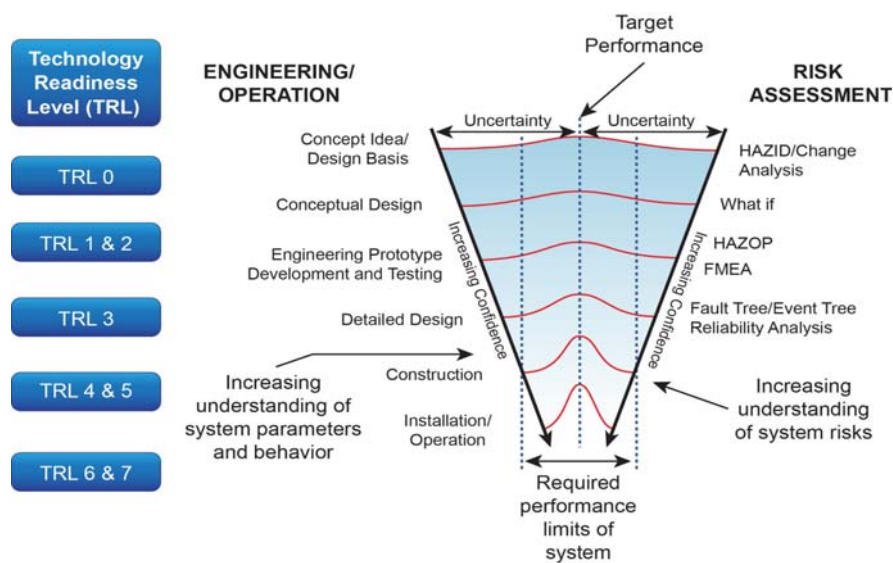
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HPHT Technology Qualification Process: API RP 17N

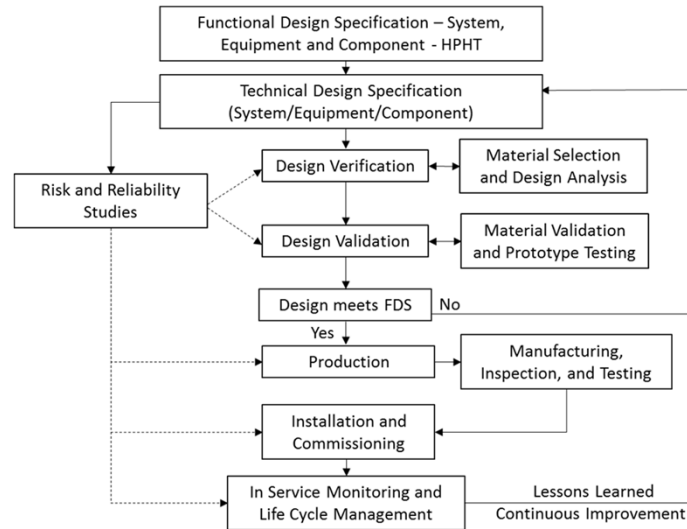
	TRL	Description of development level completed
Concept	0	Unproven Concept: Basic R&D, Concept developed on paper.
	1	Proven Concept: Through analysis, study, R&D experiments.
Proof of Concept	2	Validated Concept: Through physical model tests in laboratory environment.
	3	Prototype Tested: Prototype built, function, performance and reliability tested.
Prototype Tested	4	Environment Tested: Pre-production system is qualification tested in simulated or actual environment.
	5	System Tested: Built as production unit, integrated into intended system and functionally tested.
Field Qualified	6	System Installed: Production unit built, integrated, fully tested in intended environment and operated for less than 3 years.
	7	Field Proven: Fully integrated production unit installed and operating for more than 3 years. Demonstrated low risk of early life failures in field.

TRL should be 5 for installation. Note that Qualification continues into in-service phase.

HPHT Technology Qualification Process



Overall TQ Flow Process



20 ksi HPHT Drilling Systems - ABS Engagement

- ABS Is carrying out technology qualifications with GE, Cameron and NOV for their 20ksi HPHT systems and equipment.
- ABS is participating in and contributing to numerous working groups and committees within API to update and develop standards relative to or associated with HPHT systems and equipment. These include Std 53, Std 16A, Spec 16AR, Spec 16C, Spec 16D, RP 16Q, RP 64, Spec 16RCD and 92M
- Regulatory Support – The Technology qualification work has progressed to a point where the design, inspection and testing methodologies are defined. ABS is engage with US regulators (BSEE and USCG) to present the technology qualification process that is underway and seek their agreement/acceptance of the approach.
- MODU – new build or upgrade spec. under development
- MPD are now used in GOM and expect to be standard on most deepwater GOM drilling

Summary

- Guidance for HPHT equipment is increasingly necessary in the oil and gas industry
- Current standards, codes, and regulations provide a high level overview for environments above 15,000psi and/or 350°F; however, further detailed descriptions and guidance are in need
- The Technology Qualification process provides confidence and guidance for the owner, operator, and manufacturer to safely and systematically utilize their equipment
- MODU design need adjustment – require more capacity
- Questions



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