



World Oil[®] HPHT
DRILLING, COMPLETIONS & PRODUCTION CONFERENCE

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Qualification of a 20,000 psi Subsea BOP: A Collaborative Approach

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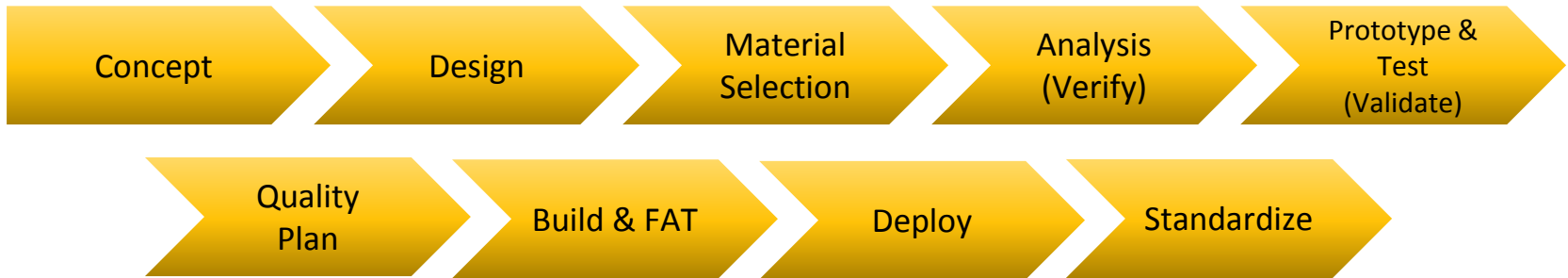
Overview

- The HPHT* Development Paradigm
- The HPHT* Development Paradigm (as applied to a 20,000 psi BOP)
- 20,000 psi BOP Stack Overview
- Functional & Technical Specification Development
- Materials Qualification Testing
- Verification Analysis
- Validation Testing
- Independent Third Party Review

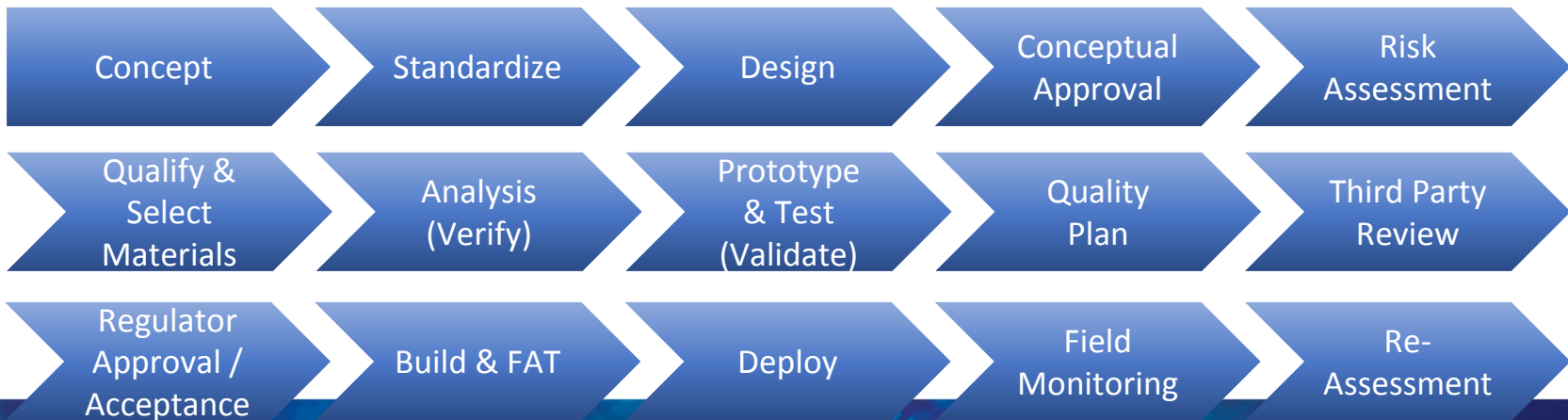
**HPHT: > 15,000 psia
rated pressure and/or
> 350°F rated
temperature*

HPHT—A New Development Paradigm

Traditional Development



HPHT Development



The HPHT Landscape (Minefield?)

Regulator

- 30 CFR 250.804
- CDWOP / DWOP
- Technical Assessment Section
- Accept / Approve qualification reports

Industry

- API 1PER15K
- API 17TR8
- Equipment-specific standards
- Issue-specific task groups

Independent Third Parties

- Review qualification documents
- Prepare & resolve findings
- Prepare qualification reports

Operator

- Generate Requirements
- Systems Analysis
- Functional specifications
- Submit qualification reports to regulator

OEM

- Technical specifications
- Equipment design & prototyping
- Materials Testing
- Verification & Validation

20k BOP Collaborative Partnership



- 30 CFR 250.804
- 30 CFR 250 Subpart G
- Engagement via CDWOP / DWOP Process
- Final report review



- Analyze all BOP Operations (Drilling, Completion, Intervention)
- Create BOP functional specification
- Technical oversight of OEM qualification



- Delineate between I3P, BAVO & Class functions
- Review qualification documents
- Prepare & resolve findings
- Prepare 1A – 1G reports



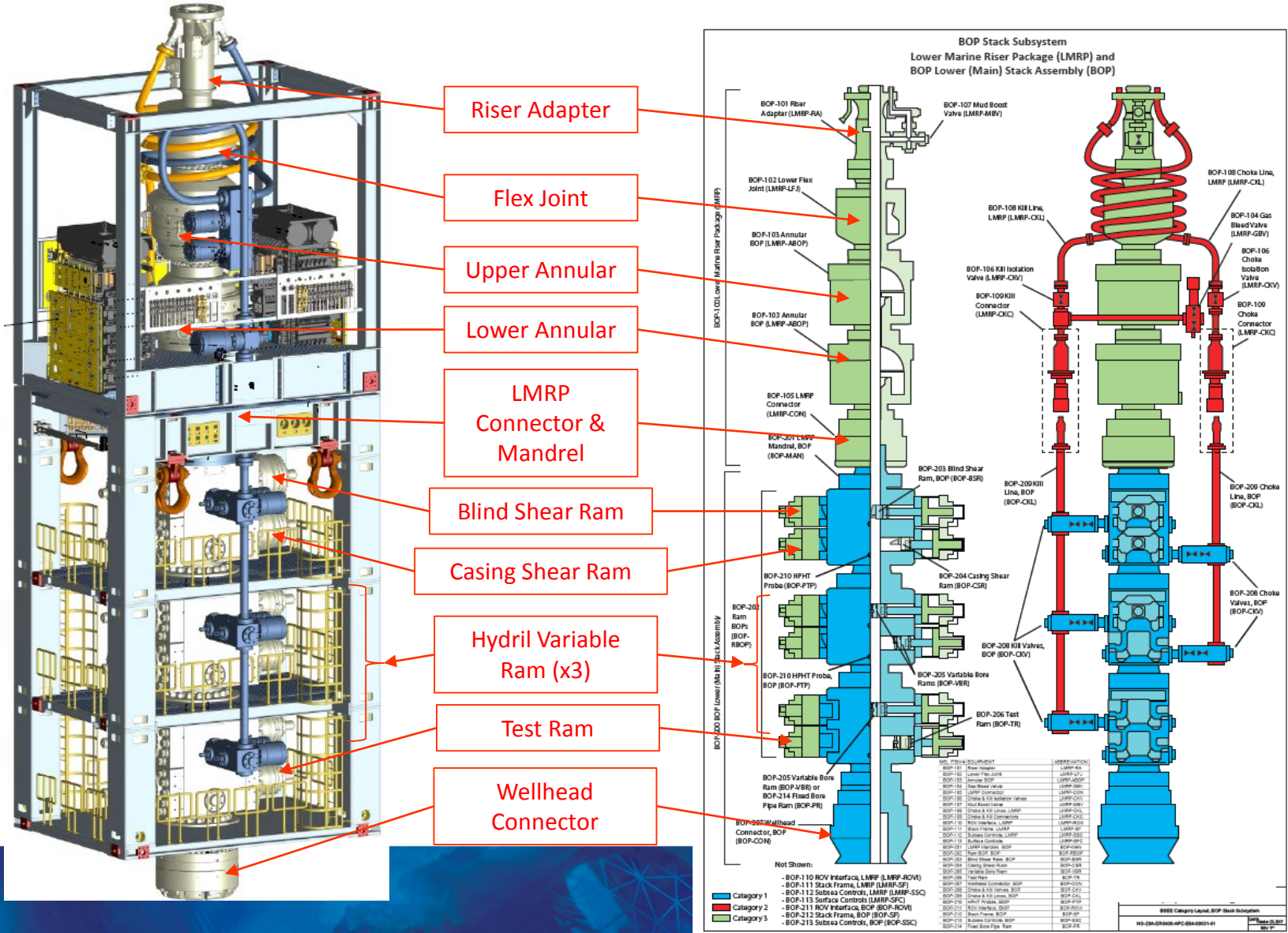
- Create Annex to API SPEC 16A (BOP equipment standard) to address HPHT equipment qualification
- Incorporate earlier API HPHT requirements & guidance as applicable



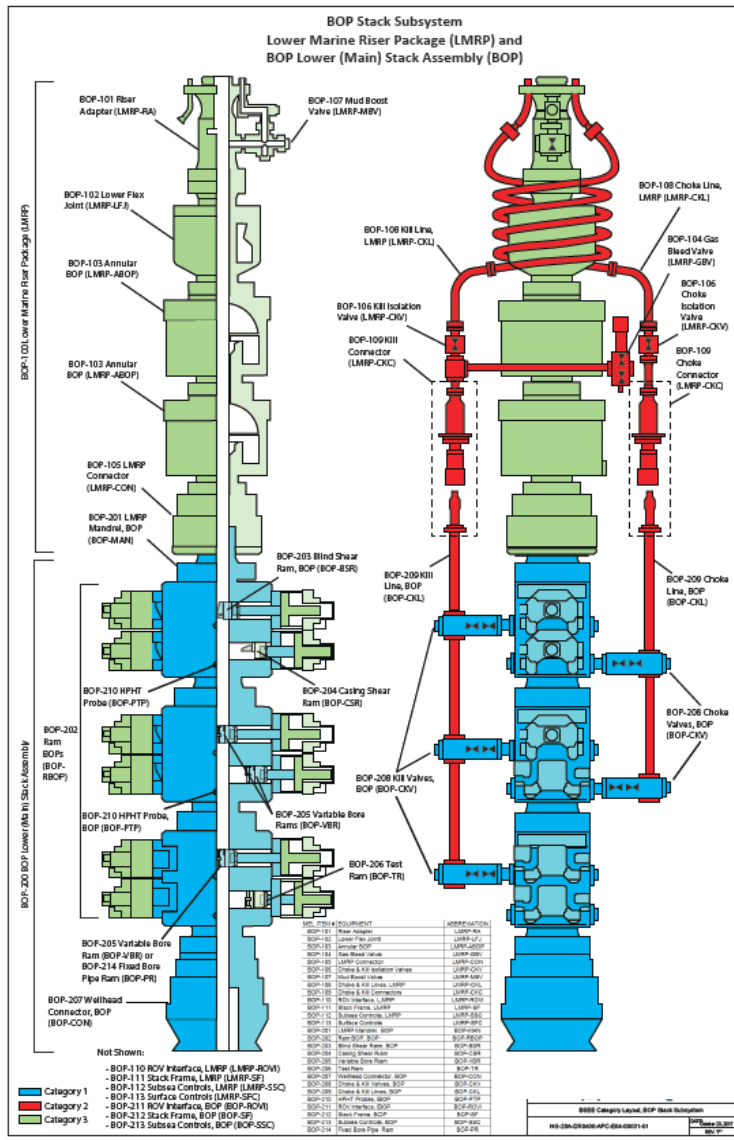
- Technical specifications Equipment design & prototyping
- Materials Testing
- Verification & Validation

Mission: Qualify & approve all new equipment necessary to build a 20,000 psi subsea BOP stack for GoM deployment

20,000 psi BOP Stack Overview



HPHT Qualification Scope



- Equipment to be qualified:
 - Category 1 (blue)
 - Category 2 (red)
- Category 3 items (green) are existing designs or non-HPHT, so do not require qualification

Once BSEE acceptance is obtained, 20k BOP stack may be manufactured for use. Separate approval required on a specific project basis.

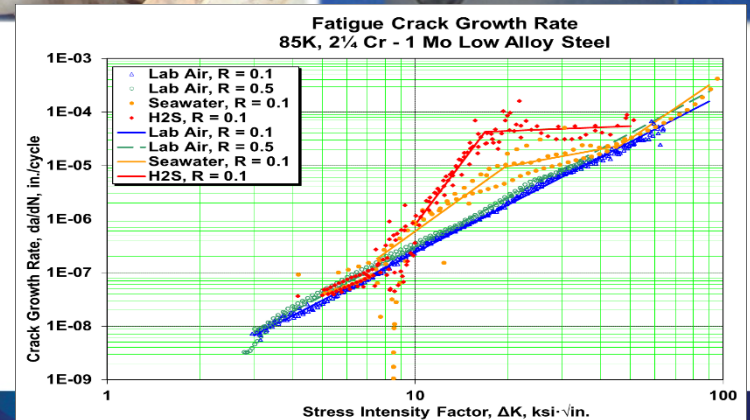
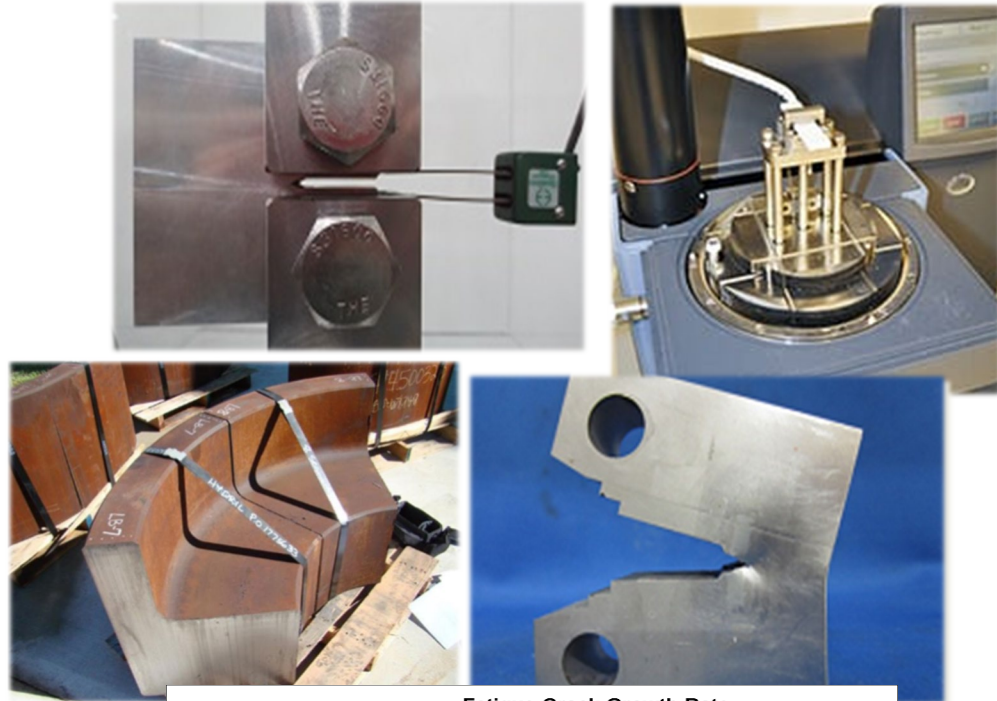
Functional & Technical Specifications

- ASME BPVC Approach:
 - User Design Specification (UDS)
 - Written by the end user
 - Defines the situation, loads, and environment
 - Consideration of all logical loading; pressure, thermal, live loading, etc.
 - Specification is site-specific
 - Manufacturer's Design Report (MDR)
 - Written by the manufacturer
 - Documents equipment ratings, materials, analysis, and testing
 - Both documents certified by Registered Professional Engineer (RPE or PE)
- BSEE / API Approach:
 - Functional Specification (FS)
 - Written by the end user (operator)
 - Defines the situation, loads, and environment
 - Consideration of all logical loading; pressure, thermal, live loading, etc.
 - Specification is site-specific
 - Technical Specification (TS)
 - Written by the equipment OEM
 - Documents equipment ratings, analysis, and testing
 - Backed by materials, verification, validation, and quality documents
 - FS, TS, and related documents reviewed by an independent third party (I3P)
 - I3P reports approved / accepted by BSEE

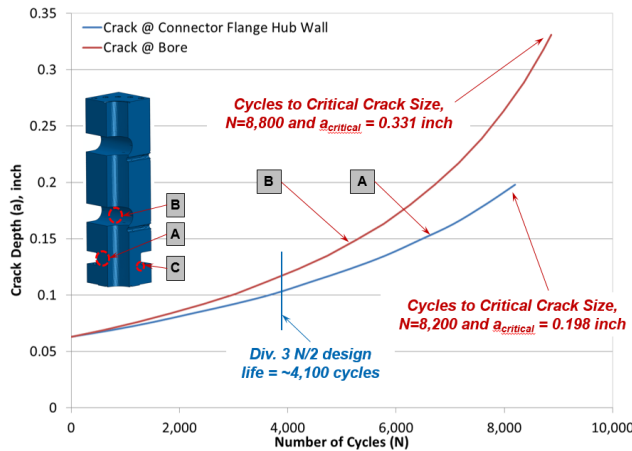
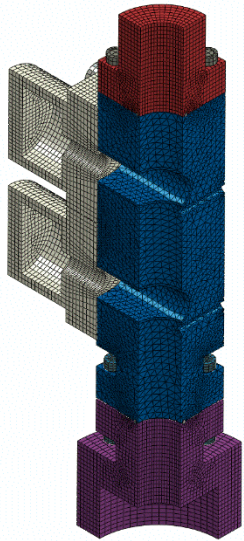
Main Difference

HPHT Materials Qualification & Selection

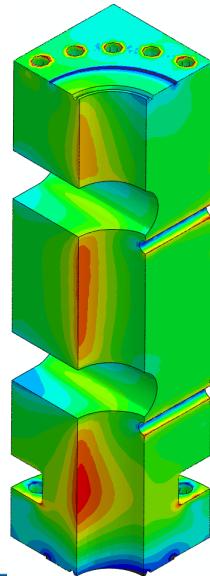
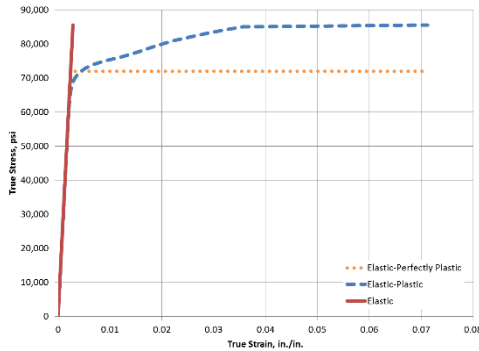
- Motivations:
 - Characterize the effect of environment on materials (at higher pressure & temp)
 - Seawater
 - Cathodic protection
 - Sour environment
 - Obtain material properties to support fracture mechanics fatigue analysis
 - Fracture toughness
 - Fatigue crack growth rate
- Both metallic & non-metallic materials
 - Sacrificial forgings & first article testing
- Test results used to justify verification analysis inputs



Verification of BOP Equipment

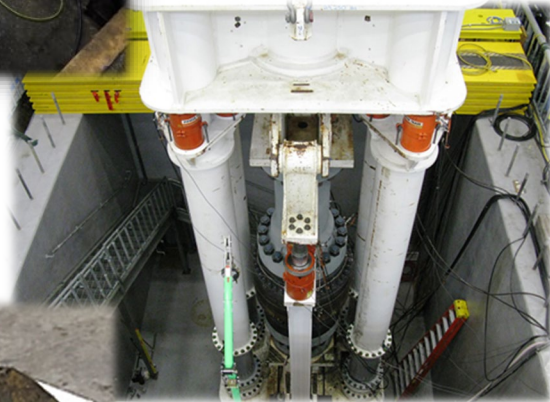


- Per API 16A HPHT Annex (Draft), based on
 - ASME BPVC Sec. VIII Div. 2 & 3
 - API 17TR8
- Checks against:
 - Plastic collapse
 - Local failure
 - Ratcheting
 - Bolting failure
 - Fatigue
 - *...but can't check everything!*

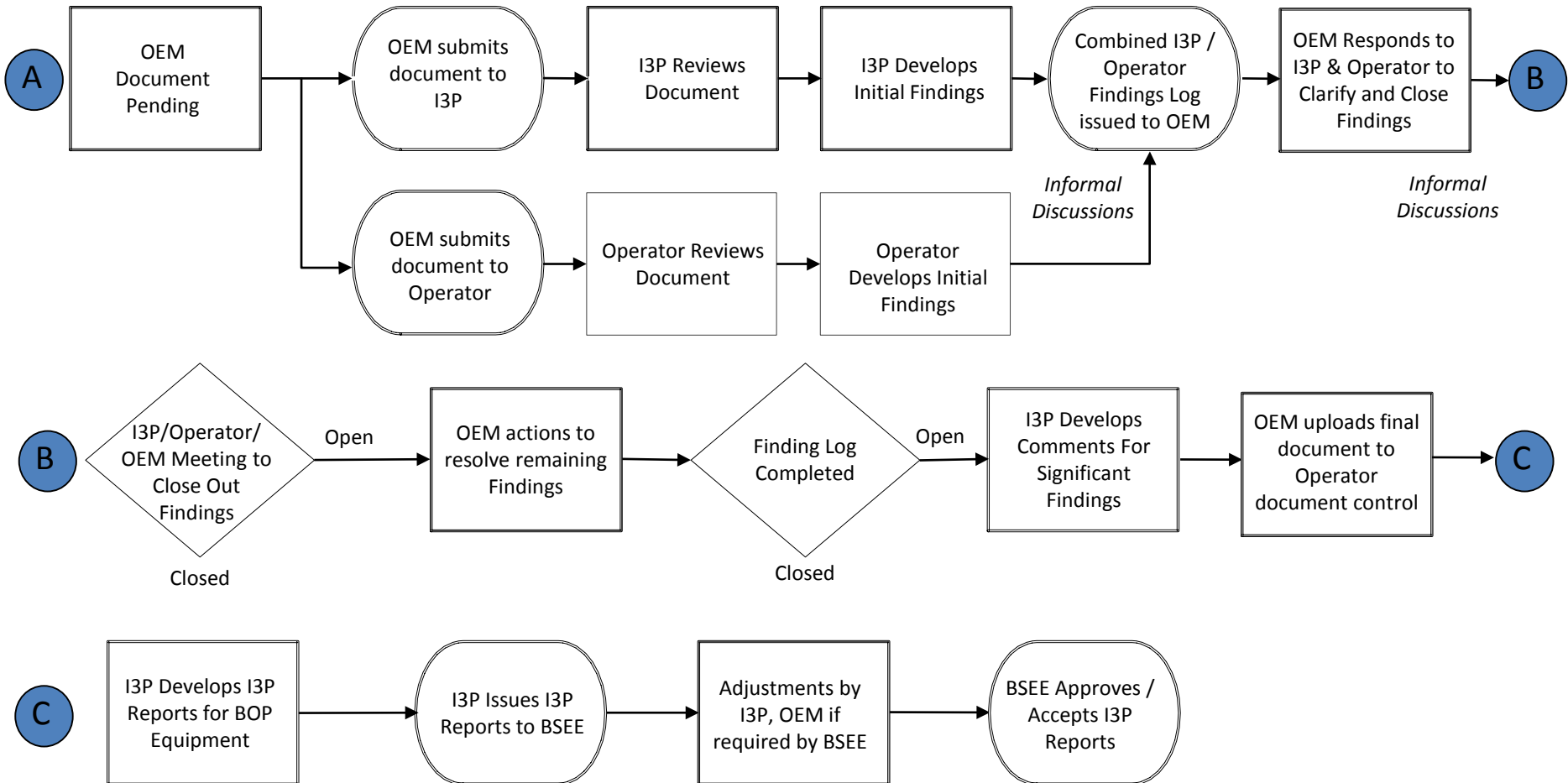


Validation of BOP Equipment

- Baseline is API 16A, 4th Edition, PR2
- Includes WHC & 18-20 flange external load testing (bending/tension) for operating, extreme, survival
- Additional testing per API 16A HPHT Annex
- Shearing per requirements of 30 CFR 250 (including 2016 Well Control Rule)
 - All pipe plus slip proof sections
 - Wireline, e-line
 - Coiled Tubing
 - External control lines



Independent Third Party (I3P) Review Process

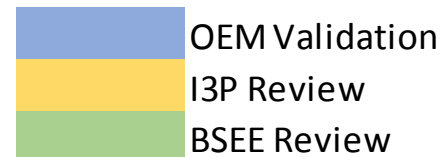


Independent Third Party (I3P) Reports

- 1A: Basis of Design
 - Technical specification & risk assessment (FMECA)
- 1B: Materials Qualification
 - Includes environmental testing reports
- 1C: Verification
 - Strength analysis
 - Fatigue Analysis
- 1D: Validation
 - Test reports per API 16A PR2, HPHT Annex
 - Includes shearing tests
- 1E: Load Monitoring
 - Plan for field monitoring of cyclic loads & reassessment
- 1F: Quality / ITP
- 1G: Fitness for service

Category 1 and 2 Equipment Qualification Status

Equipment	Category	2018		2019			
		Q3	Q4	Q1	Q2	Q3	Q4
LMRP Mandrel	1						
Ram BOP	1						
Blind Shear Ram	1						
Hydril Variable Ram	1						
Fixed Pipe Ram	1						
Wellhead Connector	1						
Choke & Kill Valve	1						
Press / Temp Probes	1						
Riser Adapter	2						
Gas Bleed Valve	2						
C&K Isolation Valves	2						
C&K Lines	2						
C&K Connectors	2						





THANK YOU & QUESTIONS

