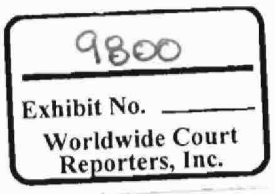
From: Smith, Trevor (GOM DWD)
Sent: Sat Jun 12 13:37:00 2010
To: Anderson, Paul (Airenergi); Austin, Julian; Breidenthal, Chase; Dominick, Leon A (DPM); Gkaras, Vassilis; Ibarra, Jim; Lanan, Kevin T; Loya, Darrell (MULLEN ENERGY); Owen, Les L; Schwebel, John; Sinsabaugh, David (LINK PROJECT SERVICES); Vicic, John; Munstereifel, Eric J (Delta Marine Tec); Hughes, John D; Bond, Stan L; Nichols, Mark; Wellings, James S; Smith, Fred (Trendsetter); Petruska, David J; Devers, Kevin J; Cargol, Mike (UNKNOWN BUSINESS PARTNER); Webber, Michael W; Elliott, Mark (FAITHFUL & GOULD INC); Timmons, Shana; Killeen, Joseph P; Mataway, Tom
Subject: 2010-06-10 Flex Joint Overshot Review Rev0.ppt
Importance: Normal
Attachments: 2010-06-10 Flex Joint Overshot Review Rev0.ppt

<<...>>
For Information - this is the presentation we made to the Government Science team on Thursday. We also reviewed the backup slides with them.
Trevor



Agenda

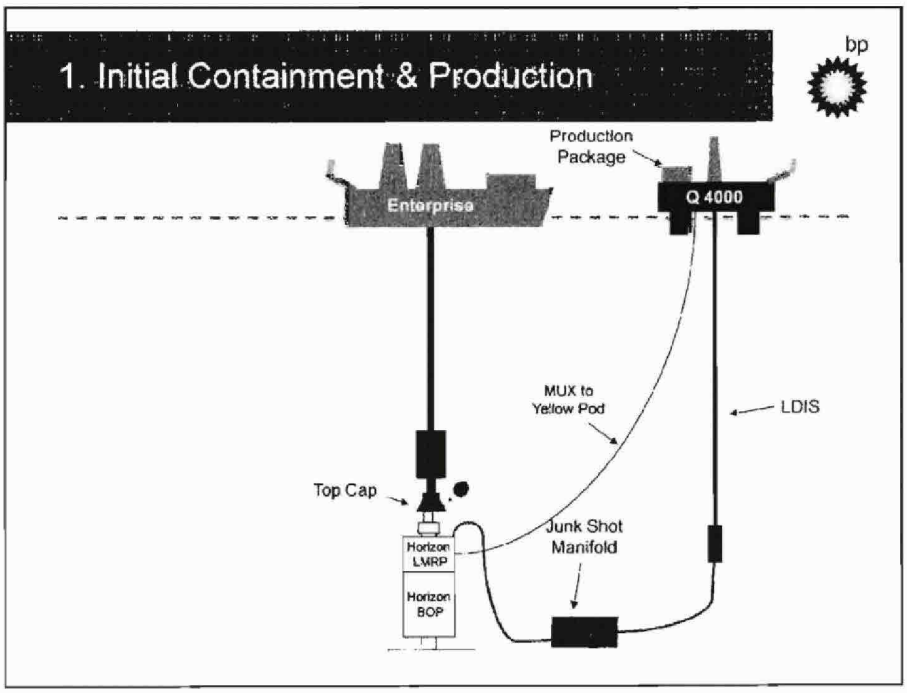
bp

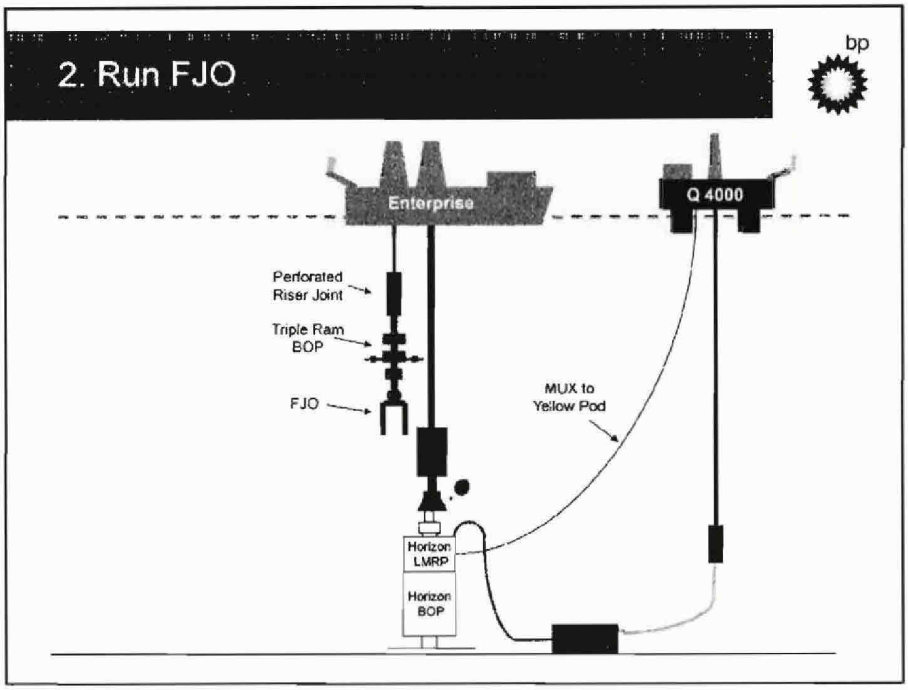
1. Context overview –Trevor Smith
2. Review of "Clamp & Grout" FJO design and the limits we found
   - design review - Julian Austin
   - grout testing - Vassilis Gkaras
3. Review of "Slips and Packers" FJO design which we are now building
   - Slips and packer background – John Vicic
   - FJO design and analysis – Julian Austin
   - FJO slip and packer test plan - John Vicic
4. 5) Field trip to visit the fabrication shop where the FJO is being built.

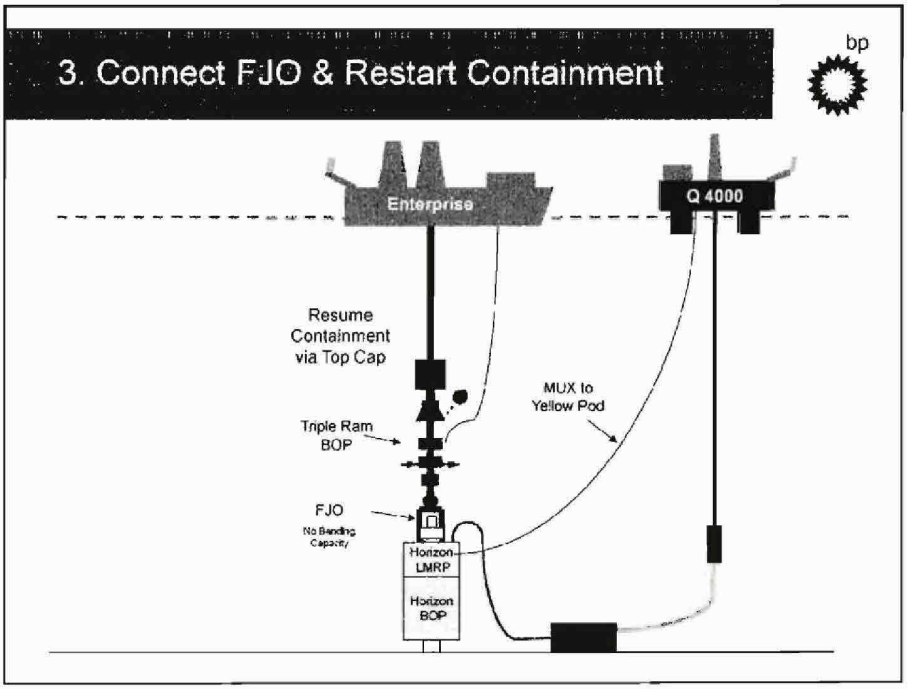
Context

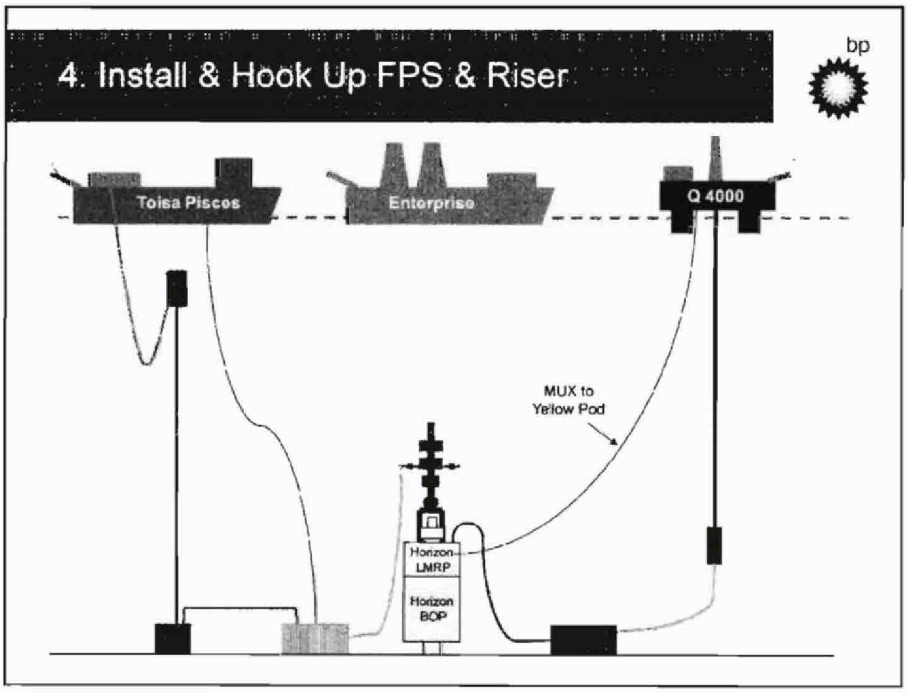
bp

1. Currently well is flowing to Enterprise drillship (at ~15000 BPD)
2. Readying Q4000 semi to take additional flow – via Horizon BOP via former Top Kill manifold system – uses existing connections
3. Building longer term containment system(s) – new manifold, freestanding riser(s), processing ship(s), and storage tanker
   - These new systems require new connections to the Horizon BOP via three options:
     a) "Flange Connection Spool" and "Capping Stack" BOP
     b) "Flex Joint Overshot" and "Capping Stack" BOP **This review**
     c) "Latch Cap" on flexjoint riser stub and flow tree
4. Potential to pull LMRP and install Capping Stack also remains in play


1. Initial Containment & Production
bp
Production Package
Enterprise
Q 4000
MUX to Yellow Pod
LDIS
Top Cap
Junk Shot Manifold
Horizon LMRP
Horizon BOP


2. Run FJO
bp
Enterprise
Q 4000
Perforated Riser Joint
Triple Ram BOP
FJO
MUX to Yellow Pod
Horizon LMRP
Horizon BOP


3. Connect FJO & Restart Containment
bp
Enterprise
Q 4000
Resume Containment via Top Cap
Triple Ram BOP
FJO
No Bending Capacity
MUX to Yellow Pod
Horizon LMRP
Horizon BOP

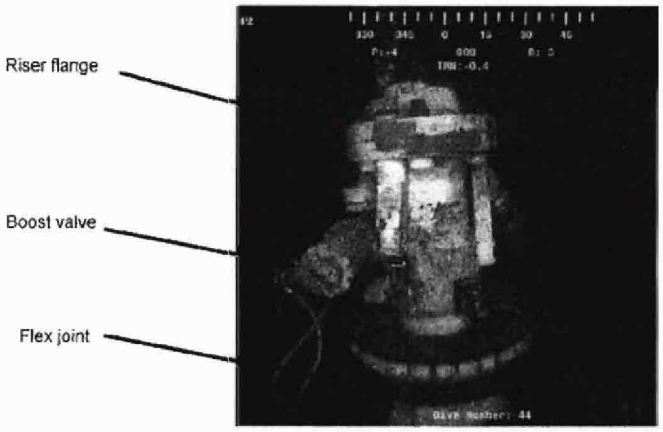

4. Install & Hook Up FPS & Riser
bp
Toisa Pisces
Enterprise
Q 4000
MUX to
Yellow Pod
Horizon
LMRP
Horizon
BOP

Summary of Flexjoint Connection Options

1. Flex Joint Overshot – Clamp and Grout
2. Grip and Seal version

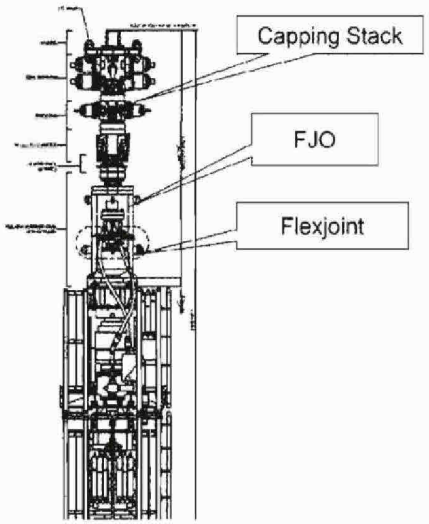
Riser Flange and Flex Joint Assembly

bp



Installed FJO Layout

bp



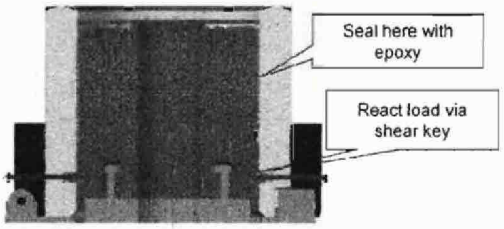
Summary of Flexjoint Connection Options

bp

1. **Flex Joint Overshot – Clamp and Grout**
2. Grip and Seal version

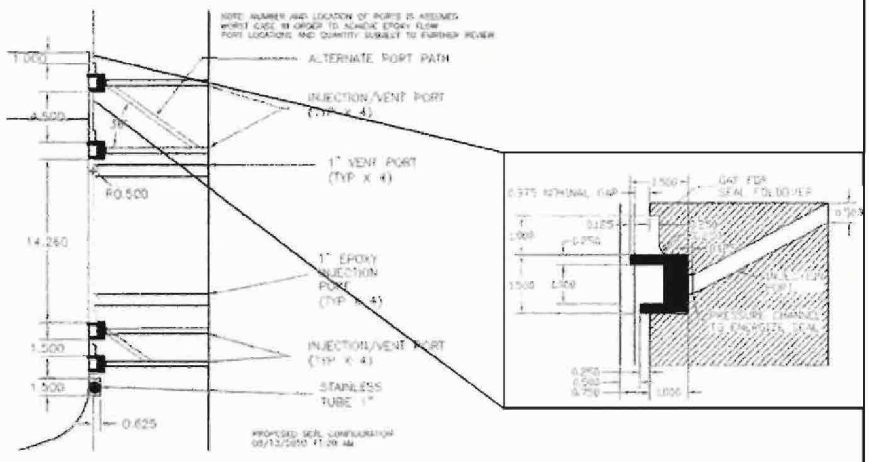
1. "Clamp and Grout"

bp



- Achieves the seal by grouting the gap between the overshot and the flexjoint bowl with an epoxy resin or cement grout
- Reacts the force via a shear key onto a load ring beneath the flexjoint bowl

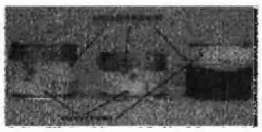
Ring Seals Design



Epoxy Resin Testing

bp

- Sandia National Labs tasked to develop procedures for evaluation of mechanical properties of potential epoxy products
- Epoxy products:
  - Thermal Chem 4 (TC-4)
  - UltraSeal Liquid Bridge Plug



- Testing conditions:
  - 40degF
  - Injection in molds with presence of brine
  - One metal platen of molds epoxy painted

Square "o" ring for alignment and sealing during curing of the epoxy.

- Methods
  - Direct Pull Tension test
  - Pipe in pipe shear test

Epoxy Resins Testing

bp

- TC-4
  - + Able to cure at 40degF
  - + Stronger in tension than Ultra-Seal
  - − More viscous than Ultra-Seal → possibility to be injected in annulus through subsea piping to be confirmed
- UltraSeal
  - + More fluid than TC-4 (viscosity similar to hydraulic oil, easily injectable in annulus space)
  - + More elastic than TC-4
  - − Not possible to cure at 40degF
- **More research/ experimentation was necessary to optimize ingredient ratio for balance of strength & curing time**

Summary of Flexjoint Connection Options

bp

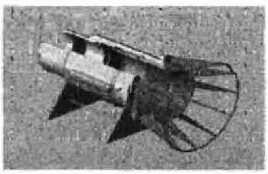
1. Flex Joint Overshot – Clamp and Grout
2. **Grip and Seal version**

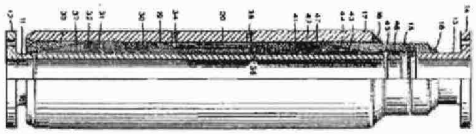
Overshot and Slip Seal Equipment

bp

- Slip and seal connections have successful history in the oilfield for more than 50 years
  - Wellhead casing hanger – API 6A 15 ksi, +250 F

  - Pipeline connectors – to 48" ANSI 600





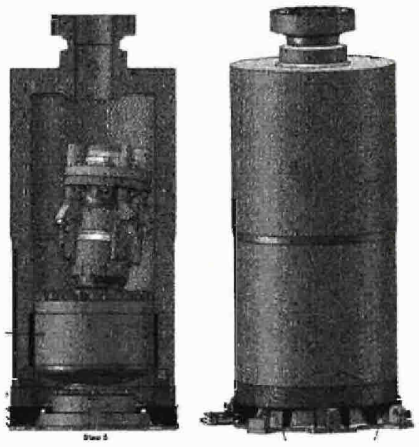
2. Flexjoint Overshot – Grip and Seal version

bp

Overview
- overshot can envelops flexjoint and grips on to flexjoint with slips and seals with a rubber packer stack
- Independent of flexjoint after installation
- 4700 psia design

Challenges
- BOP angle TBD – FJO may jam during installation
- Site preparation

Status
- Currently under fabrication
- Slips & Packer testing is being planned
- Site Integration Test scope being developed



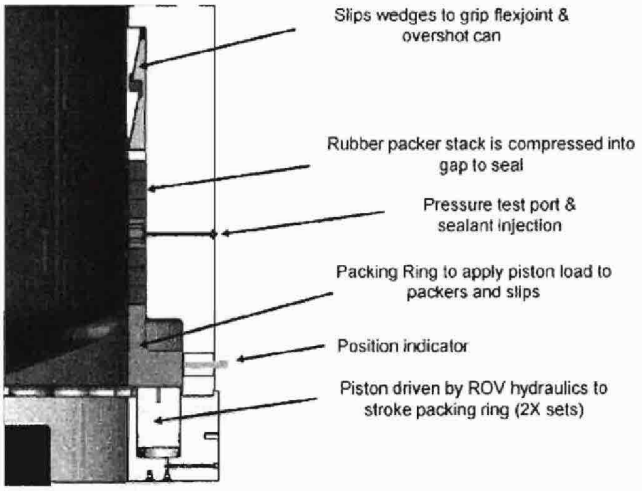
Grip and Seal Detail on Next slide

Flex Joint Overshot Key Risks

bp

ID	Risk	Mitigation
1	FJO jams at installation (BOP angle 2 degrees)	• test fit-up with inclination at onshore trial • modify design for installation at angle • drill-string installation provides installation control
2	Slips engagement on FJ	• validation testing to confirm slips engagement • remove paint on FJ
3	Packer Seals do not hold full working pressure	• conduct validation testing • full scale seal tests at onshore SIT • inject sealant to stop leaks • increase piston pressure to compress seals further
4	Hydrate formation during installation	• apply learning from Top Hat(s) experience • modeling flow, chemicals & equipment design
5	Removing Mud Boost valve actuator creates leak	• cutting tool selection, cut placement and timing to minimize risk • temporary condition pending FJO installation

FJO – Grip and Seal arrangement

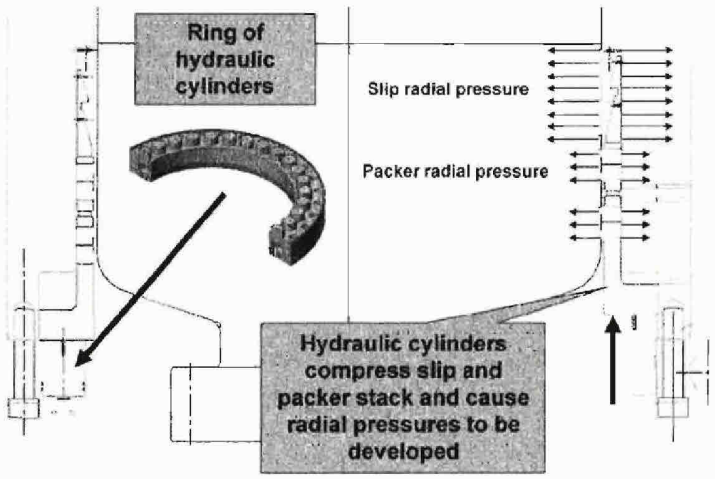


FJO – Grip and Seal Analysis

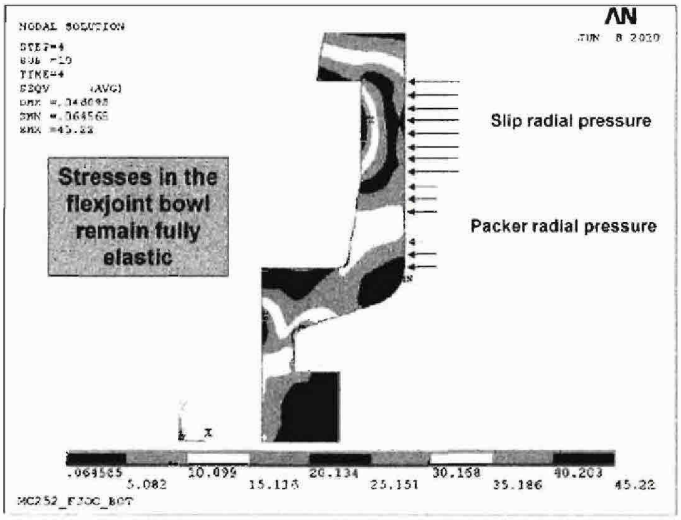
bp

- Finite element analysis of the flexjoint bowl and overshot pressure can carried out to understand:
  - Stresses in the components
  - Deflections of the components
- Pressure loadings derived from Oil States standard design calculations
- Design basis requires that:
  - Components remain substantially elastic
  - Deflections do not compromise gripping strength
- Motion study to ensure full stroke is available

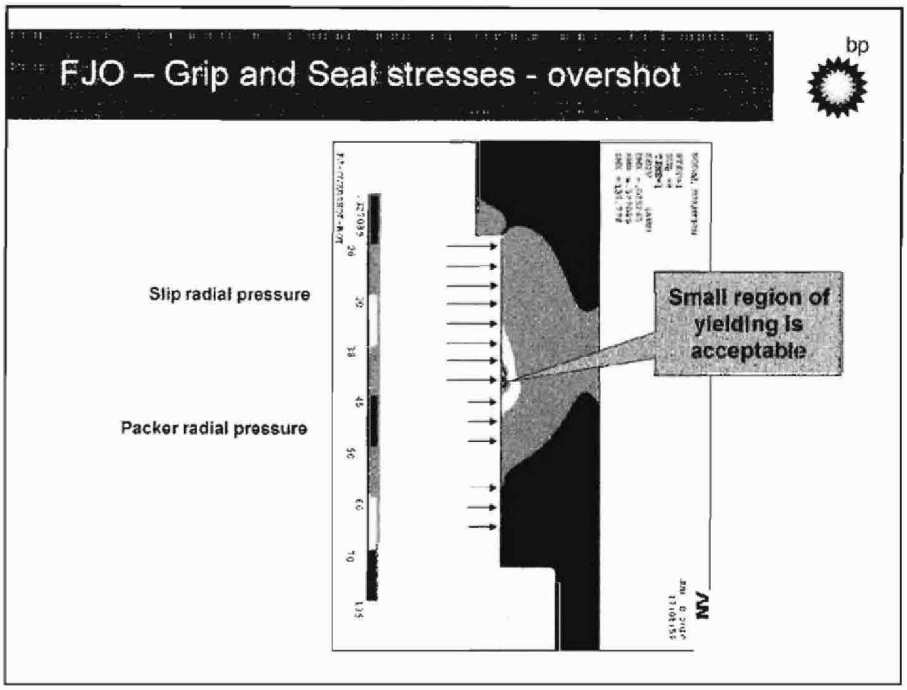
FJO – Grip and Seal radial pressures



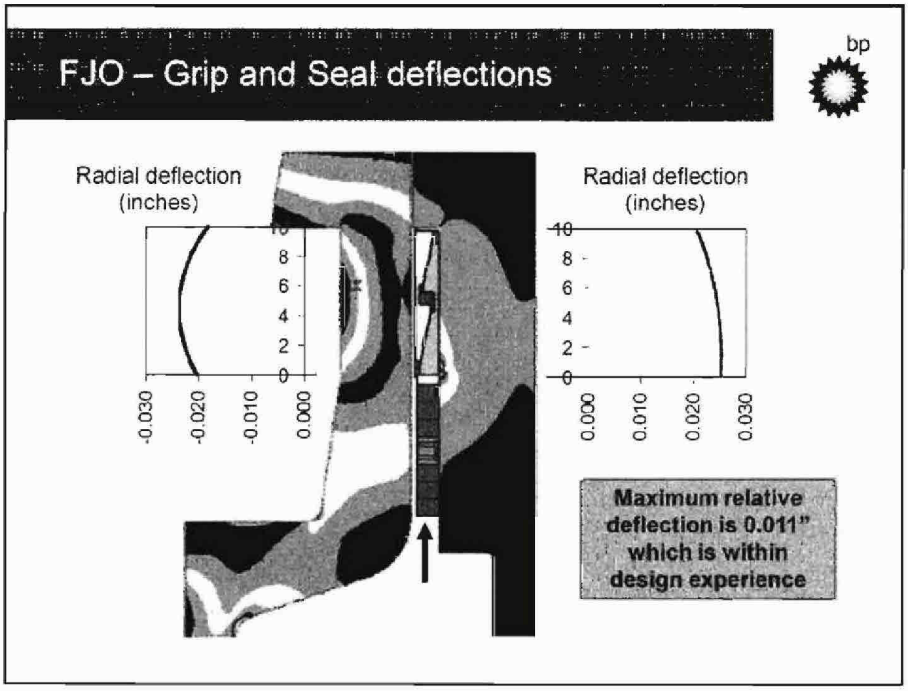
FJO – Grip and Seal stresses - flexjoint

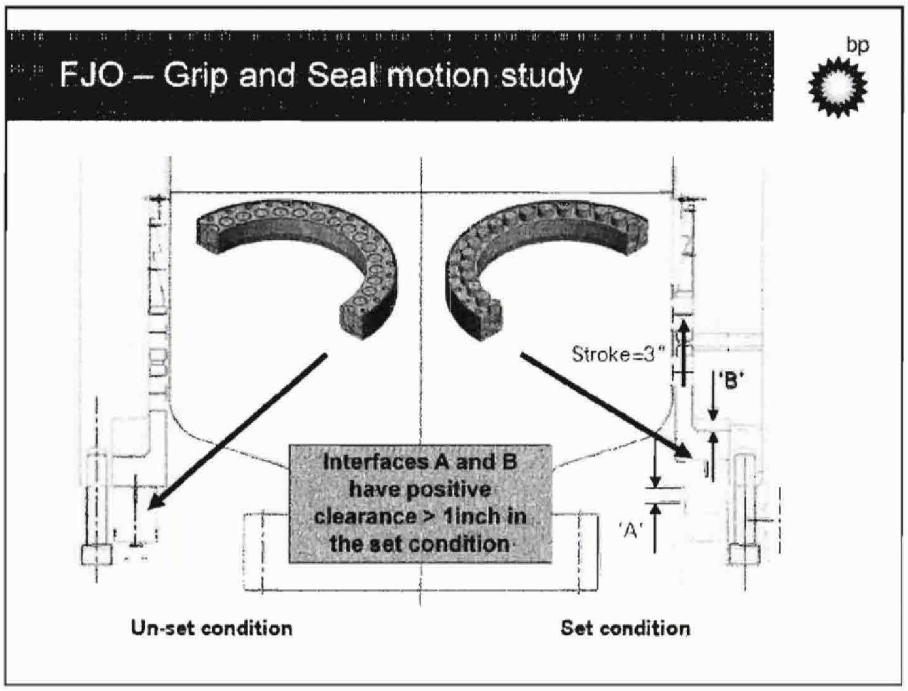


FJO – Grip and Seal stresses - overshot



FJO – Grip and Seal deflections



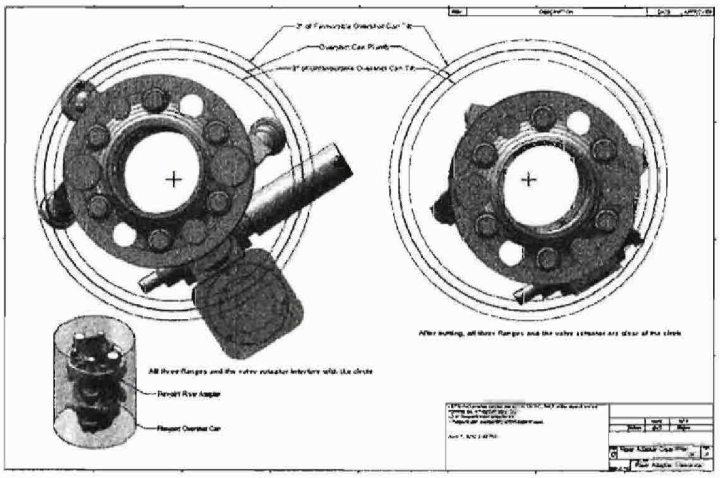

FJO – Grip and Seal motion study
bp
Stroke=3"
'B'
'A'
Interfaces A and B have positive clearance > 1inch in the set condition
Un-set condition
Set condition

24 Inch Seal and Grip Connector Validation Test

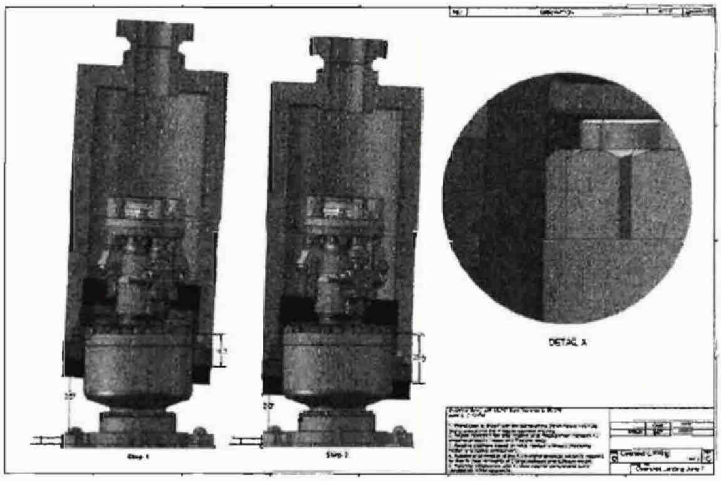
bp

- 24" PEC -8" slip at the same ramp angle of 12.5 degrees for very similar contact pressures and tooth shear stresses as the FJO with the PEC at 4700 psi.
- Hardness - carefully selected test nipple to prove that the contact pressure is also sufficient to bite into the flex joint.
- Teeth - similar shear stresses in the teeth would prove that they are low enough to maintain the integrity of the teeth. A post test inspection of the teeth and pipe would be a good indicator for the expected performance of the FJO slips.
- 3/8" radial gap -connector is to designed to make a 3/8" jump to min pipe, a test nipple will be made to min OD to force the gap.
- Seals in the same compound as the FJO, Seal test performed at the same rubber pressure required to seal 4700 psi.
- Seals will be pressured for 1 hour hold and released- 3x cycles.
- Seals with damage- retested with increased hydraulic pressure and then sealant injection.

Site Preparation



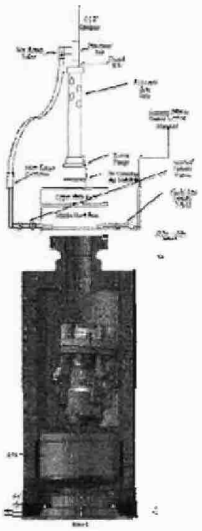
Flex Joint Landing



Hydrate remediation

bp

- Hydrate formation temperature ≈70deg F
- Hydrate remediation options:
  - glycol,
  - MeOH and/or
  - Displacement of water with N_2
- Delivery mechanism options include:
  - Drilling vessel from Installation drilling string bore
  - Installation WorkOver Control System (IWOCS)
- Key issue: try to ensure outflow of oil through bottom during installation (with fallback chemicals delivery)

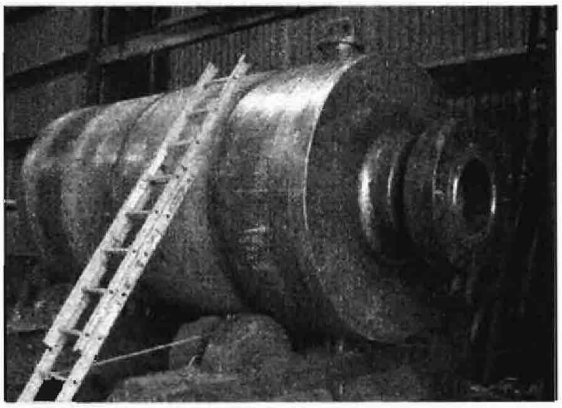


Site Integration Trials – outline scope

bp

- Investigate installability under representative conditions
  - BOP angle
  - Flexjoint angle
  - Packers & Slips protection
  - Slips engagement risks
  - Evaluation of guidance/protection systems
- Annulus test of seals (on similar flexjoint)
  - Test hydraulics & position indication
  - Seal damage tests and limits of increased pressure on packer
  - Leak repair by injection of sealant (e.g. Sealtite)

Current Status



FJO Installation - Estimated Durations

bp

Flexjoint Overshot	Critical Path Duration P50	Critical Path Duration P90	Offline Duration	Comments
Run FJO on Vessel Rigging			5	
Demo Padeyes, Grating, Hydraulic line and Mudboost Actuator	12	16	48-56	95% offline activites
Rig Remove / clear Top Hat. Commence loss of Containment	2	2		
Reposition Rig clear. Vessel move in	6	6		
Align FJO with Vessel over BOP	2	2		
Set / Lock FJO	10	12		
Align Stack 2nd Vessel	0	4		P50 considers running assembly as single unit.
Set / Lock Stack	4	6		
Vessel out / Rig In	4	6		
Rig places TH over Stack	4	6		
Critical Path	44	60	53-61	

Next Steps

bp

- Complete Machining
- Slips & Packer validation tests
- Assemble Overshot (seals, ROV hydraulics, chemicals delivery)
- SIT tests
- Replace Packers & Slips
- Ready for shipment offshore (target 24 June, zero float)

Backup Slides

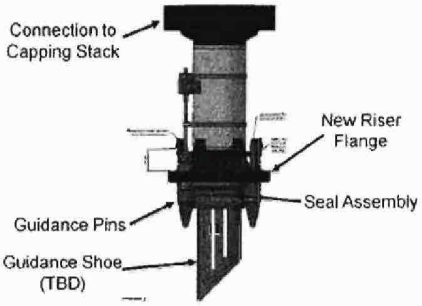
1. Flange Connection Spool

bp

Overview
- spool with new riser flange and seal assembly is connected to mating flange on Horizon LMRP Flexjoint.
- 9000 psia capable

Challenges
- unbolting and removal of flange with riser stub
- landing spool over 2 projecting drill pipe sections (exposed once stub is removed), without damaging seal assembly
- making up 6 bolts with flange spool and capping stack held on drill string

Status
- spool is built
- guidance systems being trialed this week to select best option
- In place analysis ongoing

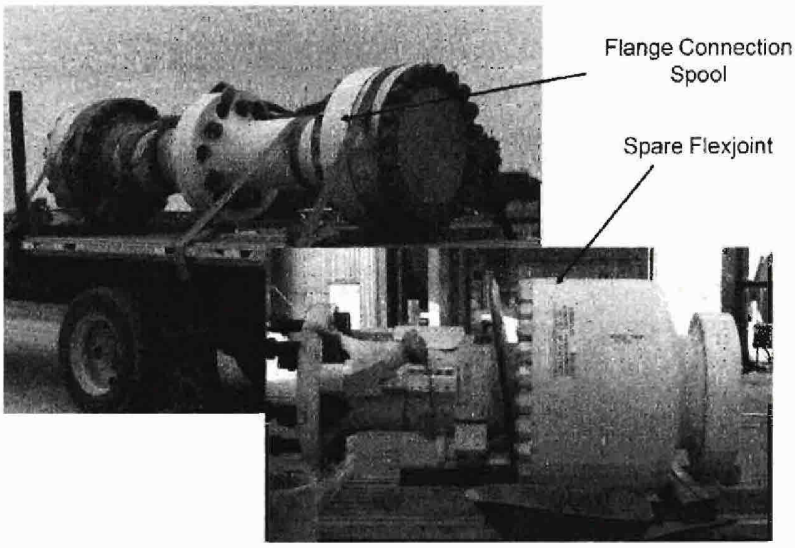


Flange Connection Spool Risks

bp

ID	Risk	Mitigation
1	Unable to undo flange bolts	• Perform subsea unbolting trial on another flange on Horizon riser to demonstrate feasibility (imminent)
2	Unable to easily remove flange (jammed)	• Identify / build tool to split flange (No flange distortion is evident)
3	Landing spool over 2 drill pipe stubs	• trialing guidance systems this week to select best option
4	Flange Spool seal damage during installation	• dual elastomeric seals reduce risk, accept less than full containment
5	Flexjoint angle	• onshore trials testing at up to 5 degrees inclination • surveying BOP to measure angles
6	Flexjoint Integrity under 9000 psia (Rated to 5000 psia)	• analysis shows low risk of FJ rupture but risk of o-ring leakage at 9000 psia • limit pressure to lower level e.g. 4700 psia

1. Flange Connection Spool contd.



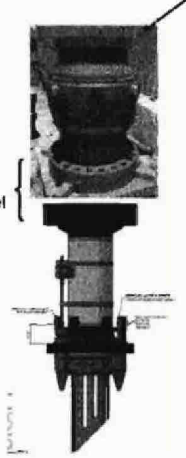
Capping Stack

bp

Status:

- Capping stack being fitted with ROV panels
- SIT scheduled for 16 June

Spool will be flanged to HC connector mandrel onshore



Flange Spool Installation - Estimated Durations

bp

Flange Connection Spool	Critical Path Duration P50	Critical Path Duration P90	Offline Duration	Comments
Run Flange Spool on Vessel Rigging			5	
Rig Remove / clear Top Hat. Commence loss of Containment	2	2		
Reposition Rig clear, Vessel move in	6	6		
Align Flange spool near BOP	1	1		
Remove Flange Bolts	18	24		
Install Flange Splitter	8	12		
Split and Remove Flange	18	24		
Deploy Flange Spool over BOP	2	2		
Install / Make-up Bolts	18	24		P50 considers running assembly as single unit.
Align Stack 2nd Vessel	0	4		
Set / Lock Stack	4	6		
Rig places TH over Capping Stack	4	6		
Critical Path	81	111	5	

Riser – cut end at riser stub

Top of Flexjoint