To Bore or Not to Bore
Introduction - To bore or not to bore

- Driver for making decisions = low HiLo for SCR’s
- The reason why it is difficult to achieve
- How SCR fit-ups can be achieved
  - Measurement of pipes
  - Finding the most cost effective solution e.g. Choosing between counterboring or not
  - Implementation of both schemes
Deep Water Riser Installation Options

- **J lay**
  - Prefabrication of double joints or quads
  - Offshore installation as quads or hexes

- **Spooling**
  - Onshore fabrication as stalks 500 - 1500 m long
  - Spooling to vessel with stalk tie-ins to complete fabrication to the vessel as completed pipeline
  - Offshore installation by unreeling through straightener

- **S lay**
  - Pre-fabricated onboard barge
J Lay

J Lay Collar

Double Joint, Quad, Quin, Hex
Spooling
S Lay
FPSO Geometries
(Floating Production Storage Offloading Facility)
Platform Geometry
Fatigue Sensitive Pipes.  

● **Risers and fatigue sensitive sections.**
  ● Dynamic structures and hence fatigue sensitive
  ● One of the most challenging aspects of deepwater development
  ● Failure would cause pollution problems

● **Issues the riser or flow-line has to deal with:**
  ● Waves
  ● Currents – more than 1 knot
  ● Winds – Hurricane Katrina decreased the expected life of risers that were affected
  ● Geological features

● **Critical regions:**
  ● Flex-joint attachment to floating vessel
  ● Touchdown region – as riser connects with sea bed
  ● Any section subject to stress
The reason for why low HiLo’s are required

- SCR’s and other pipe are subject to fatigue:
- Stress concentration occur in the regions of high HiLo
- Welding quality is improved with lower HiLo’s
- Better weld quality = fewer cutouts
- Obtaining the desired fatigue life needs to be proved not only to the operator but also to third parties i.e. MMS
Internal Pipe Joint Mismatch (HiLo)

- Internal HiLo mismatch must be less than 0.5 mm
Automatic Welding

- Automatic Welding is used routinely
- Better control over parameters improves welding reliability
- HiLo is one of the key factors
- Cut-outs are a significant expense
Welding Challenges

- Supplied pipe is generally seamless (occasionally UOE)
- Seamless pipe is typically not round or uniformly thick
- High fatigue loading – particularly at seabed touch down and riser top locations
- Misalignment must be controlled to 0.5 mm tolerance
- Wall thickness variations need to be limited
- Weld quality required is stringent
- No root flaws
- No repairs allowed
Pipe end geometry

Pipe End Geometry

Example Calliper Measurements (no common datum)

2-D Geometry in Laser Measurement Data
Fit up challenges – Pipe Geometries (exaggerated)

- 6” – 16” Seamless Pipe
- 16” upwards UOE/Spiral/HFI
Why measure?

- Extensive testing and industry experience has shown that a HiLo of more than 0.5 mm could cause a problem with fatigue and AUT inspection.
- 0.5 mm HiLo maximum has been the gold standard ever since.
- To achieve 0.5 mm in practice you need to do better than 0.5 mm to allow for misalignment in fit up.
What needs to be measured?

- External shape (OD)
- Internal shape (ID)
- Wall thickness (WT)
- Bevel geometry
- Internal weld bead
- External weld flushing
- Internal HiLo
Typical methods

- Vernier Callipers (no shape)
- Lasers (full shape)
How to achieve a 0.5 mm fit up

- Counterbore
- Part counterbore
- End-match
- Rotation
End Matching – pick pipe and rotate to fit

- pipe shapes vary
- fitting pipes together results in mis-alignment at the joint
- specification not met

How to solve this...
- measure the pipe ends
- calculate the best fit rotation
- rotate to best fit
If pipes are not rotated exactly right,

HiLo increases dramatically.

Rotation

Sweet spot
Definition of the Rotation Mark location with respect to the Free Pipe (right)

- Align Rotation Mark to Fixed Pipe Datum Mark
- Rotation Mark measured Clockwise for Positive Values
Examples of pipe fit up software

Bad fit up, shapes do not match

Good fit up, shapes match
Counterboring

- Measurement Survey to determine groups to accept common ID
- Sort to defined groups
- Bespoke pipe end lathes required
- Typically machines:
  - Clamps to OD of pipe
  - Counter bore centralised to OD
  - Pipe wall thickness eccentricity is corrected
  - Weld bevel applied with same machine accurately indexed to pipe ID
Typical Counterbore Parameters

- Dia mm ±0.5 mm
- wt mm ±1 mm
- 150-200 mm
- 4:1 taper max.
- 1.6 mm Rad. min
- Finish: Circ. <125 microinch RMS, Long. <250 microinch RMS
- wt mm ±1 mm
- Dia mm ±0.5 mm

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Example of field counterboring
Counterboring problems

- Pipe sizes vary such that choosing a single counterbore size is often not an option
- Eccentricity of the pipe Inside to Outside shapes results in considerable variations in depth of cut
- Depth of cut between 1.5 and 4.5 mm are not uncommon
- Large cut variations require two passes taking more time
Counterboring problems solution

- Choose best counterboring size
- If wall thickness is not sufficient then create a few groups of pipes to be counterbored to different ID sizes
- Vary groups by 0.6 mm to match between groups
- Typically 4-5 groups are required
Counterboring projects

- **Deimos** – GOM project for Shell fabricated by Acute Technological in USA
- **Blind Faith** – GOM project for Chevron fabricated by Subsea 7 in Scotland
- **BC 10** – Brasil project for Shell project fabricated by Subsea 7 in Ubu Spoolbase Brasil
- **Gumusut** – deepest water project is Asia for Shell executed by Sapura Acergy and Serimax in Malaysia
Partial Counterboring

- Identification of wall thickness issues is key to managing problems before they occur not when they occur.
- Discussions with the client can result in different approaches being adopted such as end matching, allowing black patches.
- No perfect projects with seamless pipe unless excessive wall thickness is ordered.
## To Bore or Not to Bore?

<table>
<thead>
<tr>
<th>Counterbore</th>
<th>End Match</th>
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<tbody>
<tr>
<td><strong>For</strong></td>
<td><strong>For</strong></td>
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<tr>
<td>Regular size pipes</td>
<td>Full retention of material</td>
</tr>
<tr>
<td>Extra expense</td>
<td>Pipes have to be ordered</td>
</tr>
<tr>
<td>WT variation less = good for AUT</td>
<td>No counterboring costs</td>
</tr>
<tr>
<td>Large WT material removed</td>
<td>WT variations can cause additional AUT scans</td>
</tr>
<tr>
<td>Meets 0.5 mm specification</td>
<td>Meets 0.5 mm specification</td>
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