Sureflex JIP - sharing the latest flexible pipe integrity management guidance and operational experience

Subsea Expo, AECC, 8th February 2018
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Sureflex JIP project history

1990

2000
- UKOOA Flexible Pipe Integrity JIP

2010
- Sureflex JIP (2009/10), Oil & Gas UK

2020
- Sureflex network (proposed)
Sureflex JIP scope and participants

**Scope**
- Population and damage statistics
- Inspection and monitoring review
- Share IM good practice / guidance
- Review technology development
- Share operator case studies

**Participants**
- 13 members, plus non-member contributions
- ~40 contributor organisations
  - Operators, manufacturers, certification bodies, regulators, engineering contractors, inspection / monitoring vendors
JIP publication

Full report publication
• Flexible Pipe Integrity Management Guidance & Good Practice

Published by Oil & Gas UK
• https://oilandgasuk.co.uk/product/flexible-pipe-integrity-management-guidance-good-practice-sureflex-jip/
Flexible pipe population statistics

![Graph showing cumulative manufactured length of flexible pipes](chart.png)

- **Flowlines**
- **Risers**
- **Jumpers**

**Cumulative manufactured length**
- flowlines, risers, jumpers
Example population statistics
Example population statistics

![Population distribution chart]

- **0 to 100**: 17.3%
- **100 to 200**: 21.5%
- **200 to 300**: 3.8%
- **300 to 400**: 7.9%
- **400 to 500**: 3.4%
- **500 to 750**: 5.4%
- **750 to 1000**: 4.4%
- **1000 to 1250**: 10.1%
- **1250 to 1500**: 12.4%
- **1500 to 1750**: 4.3%
- **1750 to 2000**: 4.4%
- **2000 to 2250**: 0.9%
- **2250 to 2500**: 2.2%
- **2500 to 2750**: 1.8%
- **2750 to 3000**: 0.0%
- **3000 to 3250**: 0.1%
- **3250 to 3500**: 0.0%
- **over 3500**: 0.0%

*Range, Design Water Depth (m)*
Damage and failure experience – biggest drivers

- Damage and failure categorised in full, by:
  - 37 separate damage / failure causes
  - 8 separate status criteria;
    - e.g. damaged, leak, minor defect, shutdown, rupture
- Biggest drivers (in grouped / consolidated causes)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Damaged</th>
<th>Failed – Leak</th>
<th>Failed - Rupture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Riser</td>
<td>Flowline &amp; Jumper</td>
<td>Riser</td>
</tr>
<tr>
<td>1</td>
<td>Annulus flooding 109 cases, 47%</td>
<td>Annulus flooding 19 cases, 63%</td>
<td>Internal pressure sheath 29 cases, 46%</td>
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<tr>
<td>2</td>
<td>Ancillary equipment 59 cases, 26%</td>
<td>Global pipe defects 9 cases, 30%</td>
<td>Armours 10 cases, 16%</td>
</tr>
<tr>
<td>3</td>
<td>Carcass 29 cases, 13%</td>
<td>Pigging damage (1 case) Internal pressure sheath (1 case)</td>
<td>Carcass 7 cases, 11%</td>
</tr>
<tr>
<td>Total cases</td>
<td>197 (85% of damaged risers)</td>
<td>30 (100% of damaged flowlines &amp; jumpers)</td>
<td>46 (73% of riser leaks)</td>
</tr>
</tbody>
</table>
Damage and failure statistics

- **Risers**
  - Damaged
  - Failed - Leak
  - Failed - Rupture

- **Flowlines & Jumpers**
  - Damaged
  - Failed - Leak
  - Failed - Rupture

<table>
<thead>
<tr>
<th>Period</th>
<th>Damage</th>
<th>Leak</th>
<th>Rupture</th>
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<tr>
<td>1996-2001</td>
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<td>1.E-03</td>
<td>1.E-02</td>
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<td>2001-2006</td>
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<td>2006-2011</td>
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<td>2011-2016</td>
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Damage and failure experience

**Damage / failure rates in decline since mid ’90s**

- PARLOC shows that flexible pipe compares favourably with rigid pipe based on LOC per pipe
- Experience of survival in abnormal events
  - e.g. excessive offsets, extreme storms

**However…**

- Some increases in corrosion and fatigue
- Rates may not have reached equilibrium
- Oldest pipes age ~40yrs
  - and manufactured in low numbers
Failure mechanisms identified since 2010 JIP

- Fatigue failure in the main pipe section
  - Local to bend stiffener region
- Carcass tearing failures
  - Axial loading on carcass and axial movement relative to outer
Failure mechanisms identified since 2010 JIP

- Smooth bore riser ruptures
  - Reverse permeation in pressurised J-tubes => internal sheath failure => inner annulus pressurised => armours overloaded
  - Historical failures not previously reported / shared
Experience since the JIP, and the future

- Keeping the statistics up to date => ongoing learning
  - Standardised reporting template created in JIP
  - Events can be submitted to sureflex@woodplc.com
- Sureflex Network, ongoing initiative to
  - Capture and maintain damage / failure statistics
  - Share global lessons learned
Experience since the JIP, and the future

- Some additional events since the JIP completion

<table>
<thead>
<tr>
<th>Consolidated Failure Groupings</th>
<th>Number of cases, by Status...</th>
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<th>Total No.</th>
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<td>Operating (minor defect / damage)</td>
<td>Riser</td>
<td>Flowline &amp; Jumper</td>
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<tr>
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<td>Damaged (failure initiator)</td>
<td>Riser</td>
<td>Flowline &amp; Jumper</td>
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<td></td>
<td>Failed - Leak</td>
<td>Riser</td>
<td>Flowline &amp; Jumper</td>
<td>Riser</td>
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<tr>
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<td>Failed - Rupture</td>
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<td>Flowline &amp; Jumper</td>
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<td>Flowline &amp; Jumper</td>
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<td>Armours</td>
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Inspection and monitoring methods (extract)

- Workshop reviews; industry take-up, feedback, TRL – ~35 technologies reviewed
- Per technology; benefits, limitations, procedure, industry practice, and guidance notes

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<thead>
<tr>
<th>Inspection / Monitoring / Technology</th>
<th>Appendix B Reference Tables</th>
<th>Monitoring</th>
<th>Inspection / Testing</th>
<th>Take Up</th>
<th>JIP Member Feedback</th>
<th>Ancillary Equipment</th>
<th>Global Riser</th>
<th>Outer Sheath</th>
<th>Tensile Armour</th>
<th>Pressure Armour</th>
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<th>Carcass</th>
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Table continued in full in JIP report and SPE technical paper (SPE-186158-MS)
Key conclusions and recommendations

Failure rates in decline since the mid-1990s
- Incident rates may not have reached equilibrium
- New failure modes are still being discovered
- Flow induced pulsations, can represent significant vibration / fatigue threat in connected pipework

Experience confirms good degree of robustness
- Extreme storm and abnormal event survival

Inspection and monitoring technologies
- Vendors continue to develop and extend capabilities

Recommend statistics kept up to date and shared
- Standardised reporting template created
- Sureflex Network with ongoing sharing
Thank you.
Questions?

To request standard reporting template, contact:
– sureflex@woodplc.com