

Sureflex JIP - Industry Guidance and Good Practice for Unbonded Flexible Pipe Systems

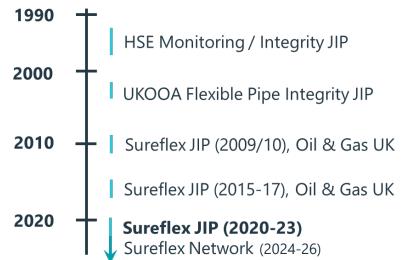
Subsea Expo '24

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The Sureflex JIP



SureFlex JIP:

- Integrity Management of Unbonded Flexible Pipes
- SureFlex JIP, lead by Wood, formed in 2010
- Previous update published 2017.
- 5th Generation JIP issued in December 2023
- <u>https://www.woodplc.com/sureflex-report-dec2023-flexiblepipeintegrity</u>
- Contributions from: Global Operators, Manufacturers, Certification Bodies, and Third-Party Vendors.
- Sureflex Network Scope in progress.

Scope of the JIP:

- Capture Population and Damage / Failure statistics.
- Share Integrity Management guidance and good practice.
- Share Operator Case Studies and identify emerging threats.
- Review Inspection and Monitoring and Repair Technologies.
- Work collectively to improve the operational integrity and prevent incidents.

THE most comprehensive and widest reaching database relating to Unbonded Flexible Pipe Integrity Management.

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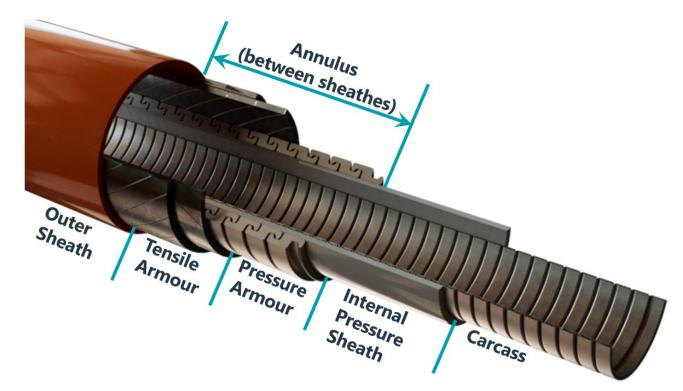
A presentation by Wood.

Flexible Pipe Construction



Key points:

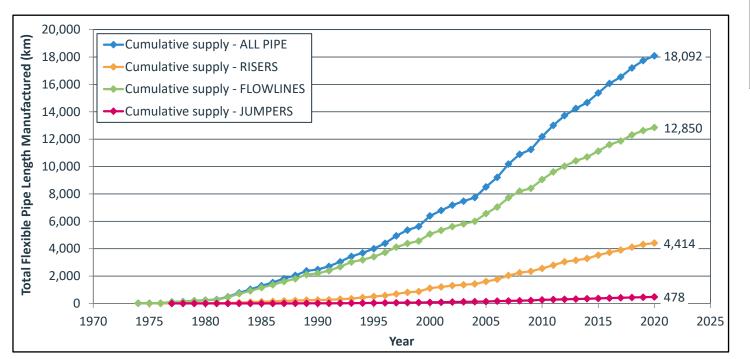
- 1. The pressure retaining layer is the pressure sheath, NOT the carcass.
- 2. Tensile armour is one continuous strip for the length of the pipe. Note: There are welds in the strips.
- 3. A flexible pipe will always have:
 - Pressure sheath
 - Tensile armour
 - Outer sheath
 - All other layers are specific to design/project requirements.

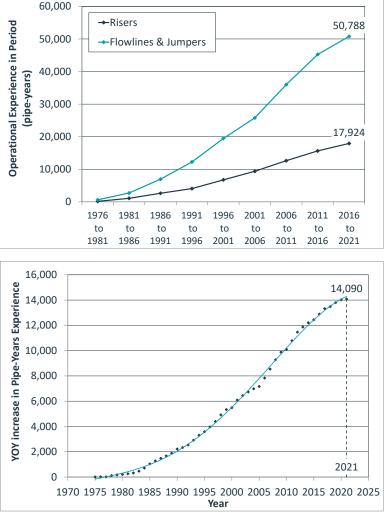


Flexible Pipe Population



The Sureflex membership includes the three main manufactures allowing the JIP to compile the most comprehensive dataset relating to the global population supply of unbonded flexible pipes.



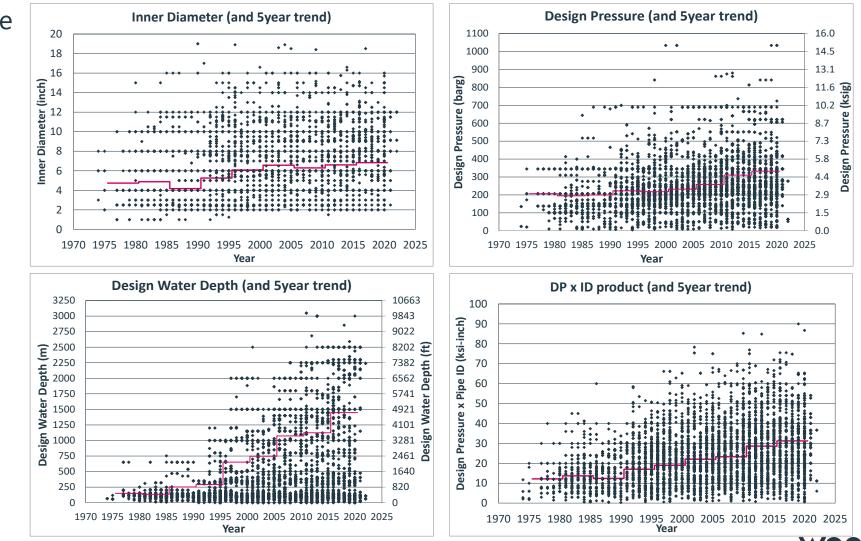


Supplied Pipe Experience



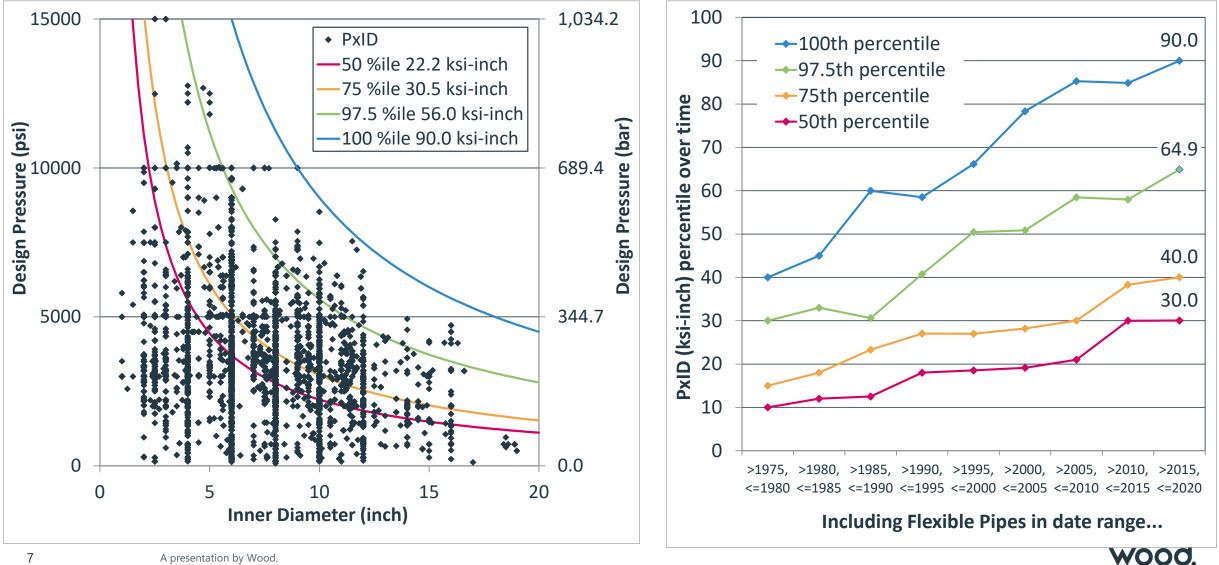
Supplied Pipe experience showing 5-year increasing trends for pipe design parameters as the operational envelope expands.

(Clockwise from top left: Inner Diameter; Design Pressure; Design Water Depth; DP x ID Product.)



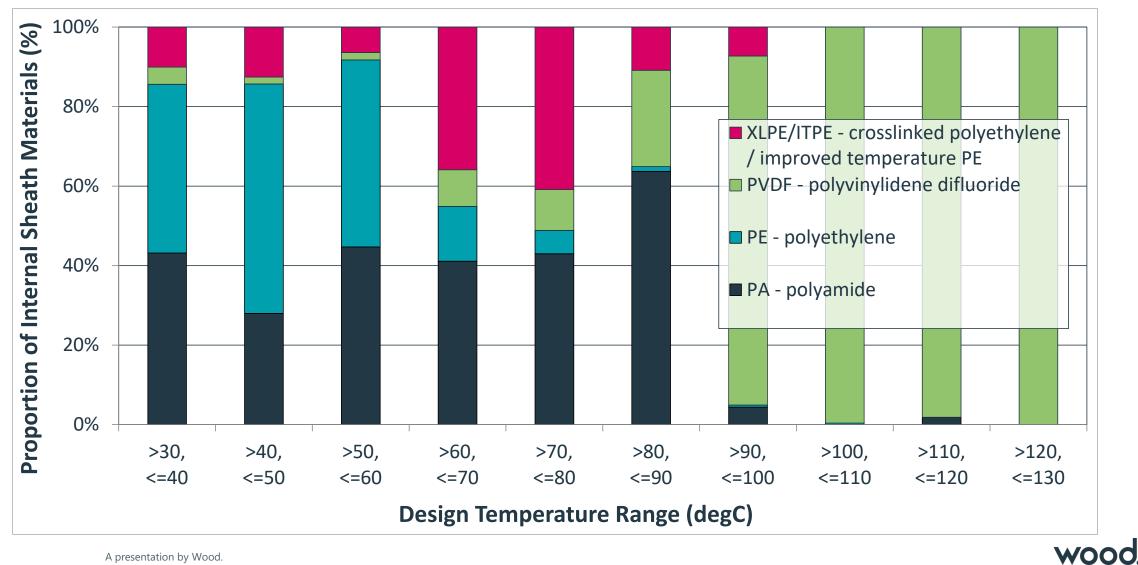
Design Pressure vs Inner Diameter





Pressure Sheath Polymers





Damage and Failure

Damage and Failure reporting from around the globe.

Used to identify trends, influence design improvements/mitigations and drive development of inspection and monitoring technologies.

Supports risk assessment development through estimation of damage/ failure rates.

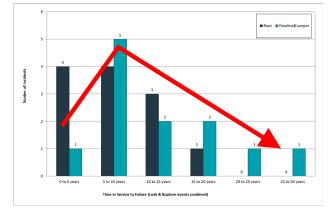
Damaged ≠ Failure and ≠ Unfit for continued operation

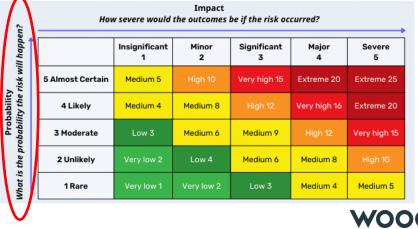
- All events are reviewed and carefully categorised by:
 - Status e.g. Minor Defect, Shutdown, Damaged, Leak, Rupture
 - **Damage Mechanism** extensive list of mechanisms to provide industry with clarity and trending

Selected event groupings are shared in the report. Members can interrogate the database directly through a Power BI Interface and create their own analyses.









	Number of cases, by status						
Damage / Failure Cause	Minor defect / damage	Shut-down (integrity concern)	Damaged (failure initiator)	Failed - leak	Failed - rupture	Total	%
Line Recovered Proactively - No significant damage / defect identified		44				44	5.0%
Carcass Failure - Fatigue				1		1	0.1%
Carcass Failure - Multilayer PVDF Collapse		9	24	6		39	4.5%
Carcass Failure - Tearing / Pullout	1	5	6	5		17	1.9%
Internal Damage - Pigging			2			2	0.2%
Internal Pressure Sheath - Ageing		27	1	21		49	5.6%
Internal Pressure Sheath - End Fitting Pull-out	2	19	3	19		43	4.9%
Internal Pressure Sheath - Fatigue / Fracture / Microleaks	2	1	3	9		15	1.7%
Internal Pressure Sheath - Smooth Bore Liner Collapse	3			6	3	12	1.4%
Tensile Armour Wire Breakage - in / close to end fitting				3	1	4	0.5%
Tensile Armour Wire Breakage - in main pipe section		1	12	1	8	22	2.5%
Tensile Armours - Birdcaging			6	13	1	20	2.3%
Corrosion of Armours - Major / Catastrophic			5	13	15	33	3.8%
Corrosion of Armours - Moderate	5	4	7			16	1.8%
Annulus Flooding - Cause Unknown	22	5	90			117	13.4%
Annulus Flooding - Defective Annulus Vent System	14		4			18	2.1%
Annulus Flooding - Outer Sheath Damage - Ageing / Fracture	1		4			5	0.6%
Annulus Flooding - Outer Sheath Damage - Mechanical / Impact / Wear	45	18	99			162	18.5%
Annulus Flooding - Permeated Liquids	2					2	0.2%
Outer Sheath Damage - Annulus NOT flooded - Ageing / Fracture	4					4	0.5%
Outer Sheath Damage - Annulus NOT flooded - Mechanical / Impact / Wear	21		6			27	3.1%
End Fitting Leak / Failure			1	25	3	29	3.3%
Ancillary Equipment - Bend Stiffener - Connection / Interface	7	2	28			37	4.2%
Ancillary Equipment - Bend Stiffener - 2 part failure			11			11	1.3%
Ancillary Equipment - Bend Stiffener - other	4		2	2		8	0.9%
Ancillary Equipment - Buoyancy Modules	1	1				2	0.2%
Ancillary Equipment - Hang-off Failure			1			1	0.1%
Ancillary Equipment - Hold-down Failure (tethers / clamps / connections)	2	-	6	<u> </u>		9	1.0%
Ancillary Equipment - Mid Water Arch	2	2	5	1		10	1.1%
Ancillary Equipment - Vent System Anomalies / Blockage	21	3	18			42	4.8%
Ancillary Equipment - Other				2		2	0.2%
Global Pipe Defect - Dropped Object / 3rd Party Interaction / Dragging	7	2	3	1		13	1.5%
Global Pipe Defect - Excess Tension					1	1	0.1%
Global Pipe Defect - Excess Torsion			2	1	1	4	0.5%
Global Pipe Defect - Flow Induced Pulsation (FLIP) causing wider system effect		5				5	0.6%
Global Pipe Defect - Ovalisation			4	10		4	0.5%
Global Pipe Defect - Overbend / Pressure Armour Unlock			5	12	1	18	2.1%
Global Pipe Defect - Rough Bore Collapse			2	1		3	0.3%
Global Pipe Defect - Upheaval Buckling	3		1	3		7	0.8%
Global Pipe Defect - Pipe Blockage (wax/hydrates/other)	3	1	9			13	1.5%
Global Pipe Defect - Excess Marine Growth			1	1		1	0.1%
Failure Mechanisme Seismenten by Wood.	1	440	0.74			2	0.2%
Total	173	149	371 42.4%	147	34 3.9%	874	100.09

Loss of Containment Cases



Damage / Failure Cause		Failed	l - leak		Failed - rupture				
	Total cases	With dates	Cases since Jul-11	Cases since Jul-16	Total cases	With dates	Cases since Jul-11	Cases since Jul-16	
Carcass Failure - Fatigue	1	1							
Carcass Failure - Multilayer PVDF Collapse	6	6	1	1					
Carcass Failure - Tearing / Pullout	5	5	1						
Internal Pressure Sheath - Ageing	21	19	2						
Internal Pressure Sheath - End Fitting Pull-out	19	19	1						
Internal Pressure Sheath - Fatigue / Fracture / Microleaks	9	8	2						
Internal Pressure Sheath - Smooth Bore Liner Collapse	6	4			3	3			
Tensile Armour Wire Breakage - in / close to end fitting	3				1	1	1	1	
Tensile Armour Wire Breakage - in main pipe section	1	1	1		8	8	8	4	
Tensile Armours - Birdcaging	13	11	1		1	1			
Corrosion of Armours - Major / Catastrophic	13	9	4		15	15	11	8	
End Fitting Leak / Failure	25	24	10	6	3	3			
Ancillary Equipment - Bend Stiffener - other	2	2							
Ancillary Equipment - Hold-down Failure (tethers / clamps / connections)	1								
Ancillary Equipment - Mid Water Arch	1	1							
Ancillary Equipment - Other	2	2							
Global pipe defect - Dropped Object / 3rd Party Interaction / Dragging	1	1	1	1					
Global pipe Defect - Excess Tension					1	1			
Global pipe Defect - Excess Torsion	1	1			1	1	1	1	
Global pipe defect - Overbend / Pressure Armour Unlock	12	9	1	1	1	1	1	1	
Global pipe defect - Rough Bore Collapse	1	1	1	1					
Global pipe Defect - Upheaval Buckling	3	3	2	1					
Failure Mechanism Disputed	1	1	1						
Total	147	128	29	11	34	34	22	15	
%	-	87.1%	22.7%	8.6%	-	100.0%	64.7%	44.1%	

Key Emergent Threats

Key emergent failure modes that have been shared with the industry during the most recent revision of the JIP:

- Stress corrosion cracking of armours due to CO₂ (rapid failure mode)
- Corrosion failures due to atmospheric backflow (airbreathing vents)
- Additional fatigue / corrosionfatigue failures with new contributory factors





Inspection Monitoring Maintenance and Repair



								Techr	nology Re	adiness Le	vel (1-7)		
	Inspection / Monitoring / Technology	Monitoring	Inspection / Testing	Maintenance / Repair	Take Up (1-5)	JIP Member Feedback (1-5)	Global Riser	Ancillary Equipment	Outer Sheath	Tensile Armour	Pressure Armour	Pressure Sheath	Carcass
1.7													

nInspection / Monitoring / TechnologyMonitoring / PrepairNomitoring / PrepairNo								Technology Readiness Level (1-7)						
B2 Valual Inspection Niver Image: Normal Inspection Niver Num	1 1	Inspection / Monitoring / Technology	Monitoring	-			Feedback		-					Carcass
B.3 Youal Inspection Roop Access IC X IC 2 4 7	B.1	Visual Inspection ROV		х		5	4	7	7	7				
B4 Visual Inspection ROAV V X 1 4 7 <	B.2	Visual Inspection Diver		х		2	4	7	7	7				
BS Wiral Inspection ROM N N 1 4 7 7 7 1 1 BF I-Ube Inspection X 2 4 7 7 7 1 1 B7 Larer Measurement X 2 4 7 7 7 1 1 B8 Marine Consth Remonal X X 3 4 7 7 7 1 1 B3 Environment Monitoring X 1 5/4 4 7 7 1 1 B4 Price State Curvature Monitoring X 1 1 N/A 6 6 1 1 B1 Offset and Mobion Monitoring X 1 1 N/A 6 6 1 1 B1 Indegrade flow Opti Stating Monitoring X 1 1 N/A 6/5 6/5 1 1 B1 Integrade flow Opti Stating Monitoring X 1 N/A 6/5 6/5 1 6/5 B1 Temperature Monitoring Remote X 1 N/A 6/5 6/5 1 7 7 B1 Temperature Monitoring Remote X 1 </td <td>B.3</td> <td>Visual Inspection Micro-ROV</td> <td></td> <td>х</td> <td></td> <td>2</td> <td>4</td> <td>7</td> <td>7</td> <td>7</td> <td></td> <td></td> <td></td> <td></td>	B.3	Visual Inspection Micro-ROV		х		2	4	7	7	7				
86I -Tube inspectionNNP24T77IIIII87Jace MessurementNX34667711188Marine Growth RenovalXX3447-711189Environment MonitoringX-5/447-711180Offset and Moton Monitoring (end Strain MonitoringX-11466-11181Integrated Flue Optic Strain MonitoringX-11466111<	B.4	Visual Inspection Roped Access		х		2	4	7	7	7				
B.7 Jacer Messurement V X Z S V T V Image Marker Scrubb Removal B.8 Marine Scrubb Removal X 3 4 6 6 V V B.10 Offset and Motion Monitoring X - 5/4 4 7 - - - B.10 Offset and Motion Monitoring X - 5/4 4 7 - - - B.11 Embedded Curvature Monitoring X - 1 N/A 5 5 - B.12 Sorard Monitoring (Berd Stiffener/Risers) X - 1 N/A 6/5 6/5 - - - B.14 Rebofk Bending Control X - X 1 N/A 6/5 6/5 - - - B.15 Emperature Monitoring Inline X - - 5 4 - 7 7 7 7 B.16 Pressure Monitoring Inline X X X 3 5 7 - - - B.17 Integrated Fibro Optic Strange X X 3 3 5 7 - - -<	B.5	Visual Inspection ROAV		х		1	4	7	7	7				
B8 Marine Growth Renoval N X 3 4 N 6 6 N N N B9 Environment Monitoring X - 5/4 4 7 - 7 N N B10 Offset and Motion Monitoring X - 11 NA 5 5 - <	B.6	I-Tube Inspection		х		2	4		7	7				
B9 Environment Montoring X X S4 4 4 7 C 7 C C 8.10 Offset and Motion Monitoring X 5/4 4 7 C <td>B.7</td> <td>Laser Measurement</td> <td></td> <td>х</td> <td></td> <td>2</td> <td>5</td> <td></td> <td>7</td> <td>7</td> <td></td> <td></td> <td></td> <td></td>	B.7	Laser Measurement		х		2	5		7	7				
B.10 Offset and Motion Monitoring X N S/4 4 7 N N N B.11 Embedded Curvature Monitoring X 1 1 N/A 5 5 0 0 B.21 Sonar Monitoring (Bend Stiffeners/Risers) X 1 1 4 6 6 0 0 B.13 Integrated Fibre Optic Strain Monitoring X 1 N/A 6/5 6/5 0 6 0 0 B.14 Retroft Bending Control X 1 N/A 6/5 6/5 0 6/5 0 B.15 Emperature Monitoring Benote X 1 N/A 6/5 4 7 7 7 7 B.16 Emperature Monitoring Benote X 1 N/A 6/5 0 6/5 0 6/5 B.17 Integrated Fibre Optic Temperature Monitoring Benote X 1 S 4 7 7 7 7 7 B.18 Pressure Monitoring Benote X X X 3 5 7 1 1 B.10 Extering Off Testing) X X 3 4 7 7 7 <td>B.8</td> <td>Marine Growth Removal</td> <td></td> <td></td> <td>Х</td> <td>3</td> <td>4</td> <td></td> <td>6</td> <td>6</td> <td></td> <td></td> <td></td> <td></td>	B.8	Marine Growth Removal			Х	3	4		6	6				
B.11 Embedded Cuvature Monitoring X Integrated Fibre Optic StatemeryRisers) X Integrate Romitoring X X X 3 3 Integrate Romitoring X X X 3 3 Integrate Romitoring X X X	B.9	Environment Monitoring	Х			4	4	7			7			
B12 Sonar Monitoring (Bend Stiffeners/Risers) X Image of the optic Strain Monitoring X	B.10	Offset and Motion Monitoring	Х			5/4	4	7						
B.13 Integrated Fibre Optic Strain Monitoring X Image and the product of the product	B.11	Embedded Curvature Monitoring	X			1	N/A	5			5	5		
B.14 Retrofit Bending Control X 1 N/A 6/5 6/5 V 7 V 7 7 7 B.15 Temperature Monitoring Imline X 2 4 6/5 6/5 0 6/5 6/5 0 6/5 0 6/5 0 6/5 0 7 <t< td=""><td>B.12</td><td>Sonar Monitoring (Bend Stiffeners/Risers)</td><td>X</td><td></td><td></td><td>1</td><td>4</td><td>6</td><td>6</td><td></td><td></td><td></td><td></td><td></td></t<>	B.12	Sonar Monitoring (Bend Stiffeners/Risers)	X			1	4	6	6					
B.15 Temperature Monitoring Inline X Image of the optic Arrow of the o	B.13	Integrated Fibre Optic Strain Monitoring	Х			2	2	6			6			
B.16 Temperature Monitoring Remote X X 2 4 6/5 6/5 6/5 B.17 Integrated Fibre Optic Temperature Monitoring X 2 4 7 7 7 7 B.18 Pressure Testing (Hydro Testing) X X 5/3 3 7 <td>B.14</td> <td>Retrofit Bending Control</td> <td></td> <td></td> <td>Х</td> <td>1</td> <td>N/A</td> <td>6/5</td> <td>6/5</td> <td></td> <td></td> <td></td> <td></td> <td></td>	B.14	Retrofit Bending Control			Х	1	N/A	6/5	6/5					
B.17 Integrated Fibre Optic Temperature Monitoring X 5 4 7 7 7 B.18 Pressure Monitoring Inline X 5 4 7 7 7 7 B.19 Pressure Monitoring Inline X 5/3 3 7 7 7 7 B.20 Topsides Annulus Vent Systems Inspection X X X 3 4 7 7 7 7 B.21 Topsides Annulus Vent Systems Inspection X X X 3 4 7 7 7 7 B.22 Topsides Annulus Notoring X X 3 4 7 7 7 7 B.23 Subsea Annulus Testing / Monitoring X X 1 N/A 6 - - - B.24 Vent Port Unbicking X X 1 N/A 6 -	B.15	Temperature Monitoring Inline	Х			5	4			7			7	
B.18 Pressure Monitoring Inline X X 5 4 7 7 7 7 B.19 Pressure Testing (Hydro Testing) X X 5/3 3 7	B.16	Temperature Monitoring Remote	Х			2	4		6/5	6/5			6/5	
B.19Pressure Testing (Hydro Testing)XXS/3377777B.20Topsides Annulus Vent Systems InspectionXXX35777 <td>B.17</td> <td>Integrated Fibre Optic Temperature Monitoring</td> <td>X</td> <td></td> <td></td> <td>2</td> <td>4</td> <td></td> <td></td> <td>7</td> <td></td> <td></td> <td>7</td> <td></td>	B.17	Integrated Fibre Optic Temperature Monitoring	X			2	4			7			7	
B20 Topsides Annulus Vent Systems Inspection X X X X 3 5 7 1 1 1 B21 Topsides Annulus Testing X X 5 4 7 7 7 7 B22 Topsides Annulus Monitoring X X 1 N/A 6 7 7 7 B23 Subsea Annulus Testing / Monitoring X X 1 N/A 6 6 7 7 7 7 B24 Vent Port Unblocking X X 1 N/A 6 6 6 6 6 7 <	B.18	Pressure Monitoring Inline	Х			5	4				7	7	7	7
B21Topsides Annulus TestingXXS4777B22Topsides Annulus MonitoringXX34777B23Subsea Annulus Testing / MonitoringXX1N/A677B24Vert Port UnblockingXX1N/A677B25Ultrasonic TestingXX447777B26Electrical Oter Sheath Breach DetectionXX1N/A577B27Fibreoptic Armour Wire Inspection (End Fitting)XX1N/A577B28Clamped Outer Sheath RepairXX1N/A5777B29Polymer Coupon MonitoringXX1N/A77777B30Bore Fluid SamplingXX1N/A777777B31X-Ray Computer TomographyXX1N/A77<	B.19	Pressure Testing (Hydro Testing)		х		5/3	3				7	7	7	
B22Topsides Annulus MonitoringXXI347I777B23Subsea Annulus Testing / MonitoringXX1N/A6IIIB24Vent Port UnblockingXX1N/A6IIIB24Vent Port UnblockingXX4477IIB25Ultrasonic TestingXX4477IIB26Electrical Oter Sheath Breach DetectionXX1N/A5IIIB27Fibreoptic Armour Wire Inspection (End Fitting)XX1N/A5IIIB28Clamped Outer Sheath RepairXX1N/ATTIIIB28Clamped Outer Sheath RepairXX447IIIIB30Bore Fluid SamplingXIN/ATTTTTTTTTTII <t< td=""><td>B.20</td><td>Topsides Annulus Vent Systems Inspection</td><td>Х</td><td>х</td><td>Х</td><td>3</td><td>5</td><td></td><td>7</td><td></td><td></td><td></td><td></td><td></td></t<>	B.20	Topsides Annulus Vent Systems Inspection	Х	х	Х	3	5		7					
BaySubsea Annulus Testing / MonitoringXXIN/A6IIIB23Subsea Annulus Testing / MonitoringXX1N/A6IIIB24Vent Port UnblockingXX1N/A6IIIB25Ultrasonic TestingXX4477IIIB26Electrical Oter Sheath Breach DetectionXXIN/A5IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	B.21	Topsides Annulus Testing		х		5	4			7			7	
B24Vent Port UnblockingXX1N/A6IIIB25Ultrasonic TestingXX44477IIB26Electrical Oter Sheath Breach DetectionXX1N/A5IIIIB26Electrical Oter Sheath Breach DetectionXX1N/A5IIIIIIB27Fibroptic Armour Wire Inspection (End Fitting)XIIN/A5IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	B.22	Topsides Annulus Monitoring	Х			3	4			7			7	
B25Ultrasonic TestingXXX447711B26Electrical Oter Sheath Breach DetectionXX1N/A511B27Fibreoptic Armour Wire Inspection (End Fitting)X1N/A511B28Clamped Outer Sheath RepairXX1N/A511B29Polymer Coupon MonitoringX447777B30Bore Fluid SamplingX44517777B31X-Ray Computer TomographyX1N/A777777B32Eddy Current InspectionXX236111B33Direct Strain MeasurementXX236611B34Magnetic Stress MeasurementXX1N/A5111 <td>B.23</td> <td>Subsea Annulus Testing / Monitoring</td> <td>X</td> <td>х</td> <td></td> <td>1</td> <td>N/A</td> <td></td> <td></td> <td>6</td> <td></td> <td></td> <td></td> <td></td>	B.23	Subsea Annulus Testing / Monitoring	X	х		1	N/A			6				
B26Electrical Oter Sheath Breach DetectionXXIN/A5IIIB27Fibreoptic Armour Wire Inspection (End Fitting)XIN/A5IIIB28Clamped Outer Sheath RepairXX347IIIIIB29Polymer Coupon MonitoringXX447IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	B.24	Vent Port Unblocking			Х	1	N/A			6				
B.27Fibreoptic Armour Wire Inspection (End Fitting)X1N/A5B.28Clamped Outer Sheath RepairXX347B.29Polymer Coupon MonitoringX447B.30Bore Fluid SamplingX447 </td <td>B.25</td> <td>Ultrasonic Testing</td> <td>Х</td> <td>х</td> <td></td> <td>4</td> <td>4</td> <td></td> <td></td> <td>7</td> <td>7</td> <td></td> <td></td> <td></td>	B.25	Ultrasonic Testing	Х	х		4	4			7	7			
B28Clamped Outer Sheath RepairNX347IIIB29Polymer Coupon MonitoringX4447777B30Bore Fluid SamplingX44507777B31K-RAy Computer TomographyX1N/A777777B32Eddy Current InspectionX2307601B33Direct Strain MeasurementXX230600B34Magnetic Stress MeasurementXX3206/540B35Microwave InspectionX1N/A500777B36RadiographyX11N/A500000B36RadiographyX111/407737/537/5B37Acoustic Emission Monitoring - Tensile ArmourX1140700006000<	B.26	Electrical Oter Sheath Breach Detection	Х	х		1	N/A			5				
B29Polymer Coupon MonitoringXX447777B.30Bore Fluid SamplingX4577777B.31X-Ray Computer TomographyX1N/A777777B.32Eddy Current InspectionXX236B.33Direct Strain MeasurementXX236B.44Magnetic Stress MeasurementXX326/54B.35Microwave InspectionXX1N/A5B.36RadiographyXX236/54B.37Acoustic Emission Monitoring - Tensile ArmourXX24/27777B.38Acoustic Emission Monitoring - CarcassX11477777B.38Internal InspectionX2466B.39Internal InspectionX23766B.39Internal InspectionX237676B.40Flexible ILIXX237676B.40Flexible	B.27	Fibreoptic Armour Wire Inspection (End Fitting)		х		1	N/A				5			
Bore Fluid Sampling X 4 5 7 7 7 7 B.31 X-Ray Computer Tomography X 1 N/A 7 7 7 7 7 B.31 X-Ray Computer Tomography X 1 N/A 7 7 7 7 7 B.32 Eddy Current Inspection X 2 3 6 7 <td>B.28</td> <td>Clamped Outer Sheath Repair</td> <td></td> <td></td> <td>Х</td> <td>3</td> <td>4</td> <td></td> <td></td> <td>7</td> <td></td> <td></td> <td></td> <td></td>	B.28	Clamped Outer Sheath Repair			Х	3	4			7				
B.31 X-Ray Computer Tomography X 1 N/A 7 7 7 7 7 B.32 Eddy Current Inspection X 2 3 7 8 7 8 <td>B.29</td> <td>Polymer Coupon Monitoring</td> <td>X</td> <td></td> <td></td> <td>4</td> <td>4</td> <td></td> <td></td> <td>7</td> <td></td> <td></td> <td>7</td> <td></td>	B.29	Polymer Coupon Monitoring	X			4	4			7			7	
B.32 Eddy Current Inspection X 2 3 7 5 1 B.33 Direct Strain Measurement X X 2 3 6 6 6 B.34 Magnetic Stress Measurement X X 3 2 6/5 4 6 B.35 Microwave Inspection X X 3 2 6/5 4 6 B.36 Radiography X X 2 4/2 7/5 3 7/5 B.37 Acoustic Emission Monitoring - Tensile Armour X 2 4/2 7/5 3 7/5 B.37 Acoustic Emission Monitoring - Carcass X 1 4 7 6 6 B.39 Internal Inspection X 2 4/2 6 6 6 B.39 Internal Inspection X 2 4 6 7 7/6 B.40 Flexible ILI X 2 3 6 7 7/6 7/6	B.30	Bore Fluid Sampling	Х			4	5				7	7	7	7
B.33Direct Strain MeasurementXXZ326IIB.34Magnetic Stress MeasurementXX326/54IB.35Microwave InspectionXX1N/A5IIB.36RadiographyX1V/AI7/537/5B.37Acoustic Emission Monitoring - Tensile ArmourXI4I7IB.38Acoustic Emission Monitoring - CarcassXI12II6B.39Internal InspectionX23II7/6B.40Flexible ILIXX23IIIII	B.31	X-Ray Computer Tomography		х		1	N/A			7	7	7	7	7
B.34Magnetic Stress MeasurementXX326/541B.35Microwave InspectionX1N/A566B.36RadiographyX24/27/57/537/5B.37Acoustic Emission Monitoring - Tensile ArmourX114766B.38Acoustic Emission Monitoring - CarcassX124676B.39Internal InspectionX2367/67/6B.40Flexible ILIX230007	B.32	Eddy Current Inspection		х		2	3				7	5		
B.35Microwave InspectionX1N/A5B.36RadiographyX24/27/57/537/5B.37Acoustic Emission Monitoring - Tensile ArmourX1476B.38Acoustic Emission Monitoring - CarcassX1266B.39Internal InspectionX2467/6B.40Flexible ILIX23077/6	B.33	Direct Strain Measurement	Х	х		2	3				6			
B.36 Radiography X 2 4/2 7/5 7/5 3 7/5 B.37 Acoustic Emission Monitoring - Tensile Armour X 1 4 7 7 6 6 B.38 Acoustic Emission Monitoring - Carcass X 1 2 6 6 6 B.39 Internal Inspection X 2 4 6 7/6 7/6 7 B.40 Flexible ILI X 2 3 0 0 7/6 7/6 7 7 6 7 6 7 6 7 6 7 7 7 6 7 7 6 7 7 6 7 7 6 7 7 7 6 7 7 6 7	B.34	Magnetic Stress Measurement	X	х		3	2				6/5	4		
B.37 Acoustic Emission Monitoring - Tensile Armour X 1 4 7 6 B.38 Acoustic Emission Monitoring - Carcass X 1 2 6 6 B.39 Internal Inspection X 2 4 6 7/6 B.40 Flexible ILI X 2 3 6 7	B.35	Microwave Inspection		Х		1	N/A				5			
B.38 Acoustic Emission Monitoring - Carcass X 1 2 Image: Carcass 6 B.39 Internal Inspection X 2 4 Image: Carcass 7/6 B.40 Flexible ILI X 2 3 Image: Carcass 7	B.36	Radiography		Х		2	4/2				7/5	7/5	3	7/5
B.39 Internal Inspection X 2 4 7/6 B.40 Flexible ILI X 2 3 7/6	B.37	Acoustic Emission Monitoring - Tensile Armour	Х			1	4				7			
B40 Flexible ILI X X 2 3 0 0 0 0 7	B.38	Acoustic Emission Monitoring - Carcass	Х			1	2							6
	B.39	Internal Inspection		Х		2	4							7/6
B.41 Flexible Dissection X 4/3 5 7 <td>B.40</td> <td>Flexible ILI</td> <td></td> <td>Х</td> <td></td> <td>2</td> <td>3</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>7</td>	B.40	Flexible ILI		Х		2	3							7
	B.41	Flexible Dissection		х		4/3	5	7	7		7	7	7	7





Inspection Maintenance Monitoring and Repair Example Tables

Standardised format for all technologies reviewed.

Generic and not vendor specific.

Captures real world experiences.

Table B.10 Technology Review – Topsides Inspection – Annulus Vent Systems

Inspection / Monitoring / Technology Name	Topsides Inspection – Annulus Vent Systems
Technology Readiness Level (TRL) (Range 1 to 7)	7
Take-Up (Range 1 to 5)	3
Industry (JIP) Feedback (Range 1 to 5)	5



Summary

The main intent of this inspection is to ensure that an unrestricted vent path exists to allow venting of permeated gasses through the topsides end fitting for all risers. De-aerated WI lines are unlikely to require ongoing venting, although access to the annulus for annulus monitoring may be of significant benefit (Refer to Table B.12).

Benefits	Limitations
 Confirms free venting of the riser a Confirms potential flow rate limitati installed system (insufficient rate of flow can lead to annulus pressure b 	tions of the vent system.
Procedure	
 any in-line valves should be verified if NRV's / PRV's are present, their full 	ee vent path exists, as follows: esent, the pressure should be recorded d as being open, and registered in a locked open / closed register unctionality should be verified, or they should be replaced ernally or retrieved via drain points, or other damage for remediation
Industry Practice	
5 1 1	intenance activity annually. It is often performed in conjunction with a ting vent ports can also be verified as being free and clear.
Guidance Note	
pressure and failure of the outer sheath. The	ts is critical to annulus integrity as it mitigates the risk of annulus over ere have been several historic reports where multiple risers have been flowing into the risers from a comingled or common vent system.

Good practice utilises NRVs between the individual risers and the vent header to mitigate against this risk. There is recent failure experience (three events) attributed to cyclic backflow of moisture / atmospheric air, leading to catastrophic corrosion failures within the end fitting which would have been prevented had NRVs been installed.

The Future

JIP Report published for free access and use by the industry.

https://www.woodplc.com/sureflex-report-dec2023-flexiblepipeintegrity

Sureflex Network 2024-2026

- Almost 100% of existing JIP members already signed up to the Network scope.
- New non-member operators of the JIP have agreed to join.
- Rapid sharing of emerging threats and lessons learned.
- Sharing feedback on emerging inspection technologies.



Working together to improve unbonded flexible pipe integrity.



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Further Information and Contact



If you have any specific questions about the integrity management of unbonded flexible pipes or would be interested in joining the ongoing Sureflex Network please reach out to the team using the below contact details:

Sureflex@woodplc.com

Any Questions?



