ICR. Products & Services

Chemical Injection Solutions
Mechanical Onsite Services
Integrity Monitoring Solutions
Quickflange™ Weldless Connections
Technowrap™ Engineered Composites
Drone-Based Inspection Services

INTEGRATED, PARTNER WITH A CONNECTED APPROACH TO INTEGRITY, CORROSION AND REPAIR.
Composite repairs can be engineered to give safe, cost effective solutions to a range of integrity issues
Why Choose a Composite Repair?

Reinstate Integrity, No Hot Work, No Shut Down, Long Design Life
Why Choose a Composite Repair?

Reinstate Integrity, No Hot Work, No Shut Down, Long Design Life

- Clusters
- Beams / Struts
- Heli-Decks
- Fire Walls / Cladding
- Structural Risers
- Decks & Walkways
Why Choose a Composite Repair?

- Reinstate integrity (pipework, pipeline, structures, decks)
- Long design life (up to 20 years)
- No hot work required
- No shutdown required
  - Can be applied to live pipework
- Significant cost saving over shutdown and replacement
- Applied by fully trained technicians
## Resin and Cloth

<table>
<thead>
<tr>
<th>Fibre Type</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>2K</td>
<td>Tri Axial Fibre Glass Cloth + Various Epoxy Resins</td>
</tr>
<tr>
<td>Structural (SRS)</td>
<td>Quadraxial Carbon Fibre Cloth + Various Epoxy Resins</td>
</tr>
<tr>
<td>HP PRS</td>
<td>Uni directional carbon fibre, 99 GPa (anisotropic)</td>
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</table>

### Key Properties

<table>
<thead>
<tr>
<th>Resin</th>
<th>Key Properties</th>
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<tbody>
<tr>
<td>Low Temp (LT)</td>
<td>Quick curing at low ambient temperatures</td>
</tr>
<tr>
<td>High Temp (HT)</td>
<td>Suitable for service temperatures up to 220°C (428°F)</td>
</tr>
<tr>
<td>High Ambient (HA)</td>
<td>Longer working life at high ambient temperatures</td>
</tr>
<tr>
<td>DRS</td>
<td>Rubber toughened to withstand impacts for decks</td>
</tr>
<tr>
<td>Glycol</td>
<td>Compatible with 100% glycol at 90°C (194°F)</td>
</tr>
<tr>
<td>Splashzone</td>
<td>Pipework in wet areas, splashzone, subsea or high humidity (and CuNi)</td>
</tr>
<tr>
<td>Potable</td>
<td>Potable water systems</td>
</tr>
</tbody>
</table>

CuNi: Copper Nickel
Applicable Standards

- Guidance on testing, design and installation
- Both standards are similar, but there are a few differences
- Result is the ISO standard gives a slightly more conservative value, given the same inputs
Adhesion

• Adhesion is measured with the Energy Release Rate
• Calculated using data points as per relevant standard
• Repair performance is controlled through the adhesion of the repair to the substrate

• Various factors affect the level of adhesion achieved;
  • Surface preparation (cleanliness and profile)
  • Substrate material
  • Repair system used
# Surface Preparation Techniques

<table>
<thead>
<tr>
<th>Surface Preparation standard</th>
<th>Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sa2.5 (60µm profile)</td>
<td>Grit blasting</td>
</tr>
<tr>
<td></td>
<td>Slurry blasting</td>
</tr>
<tr>
<td>ST3 (40µm profile)</td>
<td>Bristle blaster</td>
</tr>
<tr>
<td></td>
<td>Grinding disc</td>
</tr>
<tr>
<td>ST2</td>
<td>Emery paper</td>
</tr>
<tr>
<td></td>
<td>File</td>
</tr>
<tr>
<td></td>
<td>Needle gun</td>
</tr>
</tbody>
</table>
Design of a composite repair answers the following questions:
  • Is the repair strong enough in all loading directions? (stress/strain calculation)
  • Will the repair remain bonded to the surface? (adhesion strength calculation ERR)
  • Is the extent of repair sufficient to ensure load transfer between repair and substrate?

Design output:
  • Thickness of composite repair
  • Length of the repair

Factors to consider:
  • Pressure (operating and design)
  • Diameter/Geometry
  • Temperature
Live Leak Sealing Example
24” Seawater Line (Super Duplex)

- 24” Super Duplex Seawater line
- Weld Defects Found
- 5 bar design pressure
- Multiple geometries
14” Gas line

Overview

• 14” gas vent line suffering severe external corrosion
• Up to 40 meters of pipework affected
• Design conditions, pressure 28 bar, temperature 30°C

Why a composite solution?

• Tailored repair for the pipework
• 4 layers required over most of the pipework but where extensive corrosion was present 14 layers were applied
• Applied live – no downtime, zero impact on production
• Integrity maintained through an engineered repair solution with a life of field guarantee
Quickflange Weldless Flange to Pipe Connectors
Quickflange Weldless Flange to Pipe Connectors

Permanent Flange to Pipe connection without welding
Quickflange overview

Quickflange is a *Modified Standard Flange*

1. Quickflange is slid over the pipe, there is an end stop to ensure correct positioning
2. Quickflange Installation tool is inserted
3. Installation tool is activated and pipe is expanded into the Quickflange
4. Installation tool is retracted and removed. Installation Complete!

End

Bolt up Quickflange as a per a normal Standard flange
Quickflange Weldless Flange to Pipe Connectors

- Pipe is expanded into the flange body (grooves)
- Full pipe integrity remains – no WT reduction
- Metal to metal seal with redundancy
- Full strength, permanent connection equal to welded flange
- Indentation have no detrimental affect (flow, strength, corrosion resistance)
Product Range

Pipe Size: 3/4” - 14”
Pipe Wall: 2 - 14mm
Pressure Rating: 150# - 900#
Pipe Material: Carbon steel
Stainless steel [316, 6Mo, 22Cr, 25Cr]
Copper-nickel
Nickel alloy
Flange Geometry: ASME B16.5
EEMUA 145
EN 1092-1
Qualification and References

**ABS Product Type Approval:**
- ABS Rules for Offshore units and Structures
- ABS Mobil Offshore Drilling units Rules
- ABS Guide for classification of Drilling Systems
- ABS Rules for Building and Classing Steel Vessels
- ASME B31.3

**DNV-GL Type Approval:**
- DNV-GL OS-E101 - Drilling plant
- DNV-GL OS-E201 - Oil and gas processing systems
- ASME B31.3
- DNV-GL OS-D101 - Marine and Machinery systems and equipment
- DNV-GL rules for classification – Ships Pt.4 Ch.6 Piping systems
Tests specified by DNV and carried out by DNV in order to qualify the Quickflange Connection according to the criteria above:

a. Leakage tests / hydrostatic pressure test of all materials/dimensions: Reference 2)
b. Axial load tests of all materials/dimensions. Reference 3)
c. Bending tests of all materials/dimensions. Reference 4)
d. Torsion tests of all materials/dimensions. Reference 5)
e. Fatigue tests Reference 6)
f. Vibration tests Reference 7),8)
g. Corrosion tests Reference 9),10)
h. Metallographic examination and Cold work hardening testing Reference 11)
i. Non linear finite elements analysis. Reference 12)

3) Approval and qualification

Based on the results on the above tests DnV has qualified the Quickflange Coupling according to the criteria derived from the ASME Codes B16.5 and B31.

The QF flange may be used instead of a welding neck flange if a certain set of conditions applies. Reference 13).

4) Other Tests:

a. Sour service tested by SINTEF according to NACE TM0177. The test passed. Reference 14)
b. Burst tests of several materials/dimensions according to type approval rules (DNV/ABS/IACS) and ASME BPVC, Sec VIII Div 1, UG-101 Reference 15)
c. Fire tests of several materials/dimensions according to API 6FA Reference 16)
d. Cryogenic test Reference 17)
e. Combined vibration and pressure pulsation test according to type approval rules (DNV/ABS/IACS)
f. Gas leak tests of several dimensions according to type approval rules (DNV/ABS/IACS) Reference 19)
Testing

**TYPE OF TEST**

<table>
<thead>
<tr>
<th>Bent Strength</th>
<th>Axial Strength</th>
<th>Internal pressure</th>
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<tbody>
<tr>
<td>B&amp;T test</td>
<td>Pull Test</td>
<td>Burst test</td>
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**COMPLETED VALUES WITHOUT FAILURE**

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<tbody>
<tr>
<td>77570 Nm</td>
<td>995 kN</td>
<td>580 bar</td>
</tr>
<tr>
<td>110 kN</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Over 140% of ASME requirement
- Maximum test equipment pull force
- Pipe Failure / no alterations on the flanges

8410 psi
Why use Quickflange?

Why Use - Quickflange Pipe to Flange on Old and New Pipe

No Hot Work

- Enables efficient execution of shutdowns
- Faster work during shutdown
- Limited number of hot work permits
- Move work to outside shutdowns
- Instant readiness for permanent installation
- Increased safety
- Reduced health risks

✓ Easy installation / limited training required
✓ Suitable for confined spaces
✓ No moving parts, grips, etc
✓ “One-stop shop” for complete service
✓ Tool rental based business model
✓ Ideal for regional support inc manufacture
Overview of applications

We offer simple, reliable and efficient solutions for permanent installation of flanges and connectors when performing typical pipe system repair maintenance or modification.

**Modifications**
- New spool tie-in
- Field-fit of new pipe work
- System re-routing
- Valve / T insertion

**Permanent Repair**
- Single / multiple repair
- System repair campaign
- Flange replacement
- Replacement of temp fixes

**Construction**
- Site run piping
- On-site fabrication
- Pre-fabrication
- Use of existing penetrations
- Limited access installations

**Decommissioning**
- Blinding of lines
- Re-routing pipe work
Questions??

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