Development of Mechanical Connector Technologies

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Connector Subsea Solutions

What I will cover

- Introduction to CSS
- What is a mechanical connector
- The challenge of Clad & Lined Pipe connections
- The JIP and Type Approval Process
- The CLiP Connector
- Summary

Connector Subsea Solutions

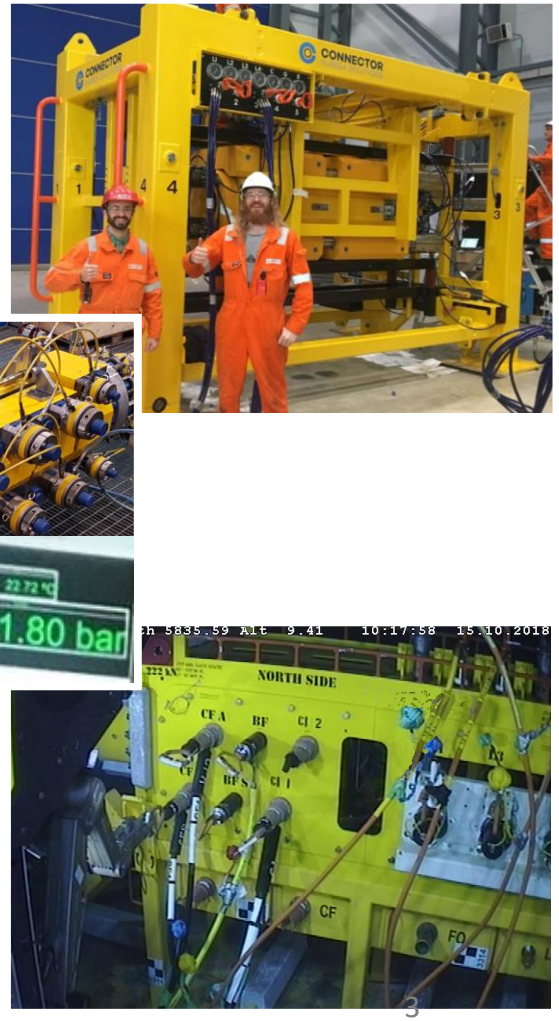
Reliable Solutions for Complex Challenges

Who are we

- Founded in year 2000
- HQ in Norway, branch offices in UK, Croatia, Bosnia, Brazil
- 60+ Employees dedicated towards pipeline repair solutions

Complete Subsea Repair Solutions

- MORGRIP Pipeline Repair Connectors & Clamps
- Connector & Clamp Installation Frames & Tooling
- Pipe Lifting & Handling, Coating Removal, Pipe Cutting, Pipe-Prep, etc
- Lightweight, Robust, ROV friendly, Unique
- ISOTEK remote welding technolgies



Mechanical Connectors

A definition:

A Mechanical Pipeline Connector provides a safe, reliable, reversible means of affecting a mechanical connection between two bare pipe ends equivalent to a good welded connection.

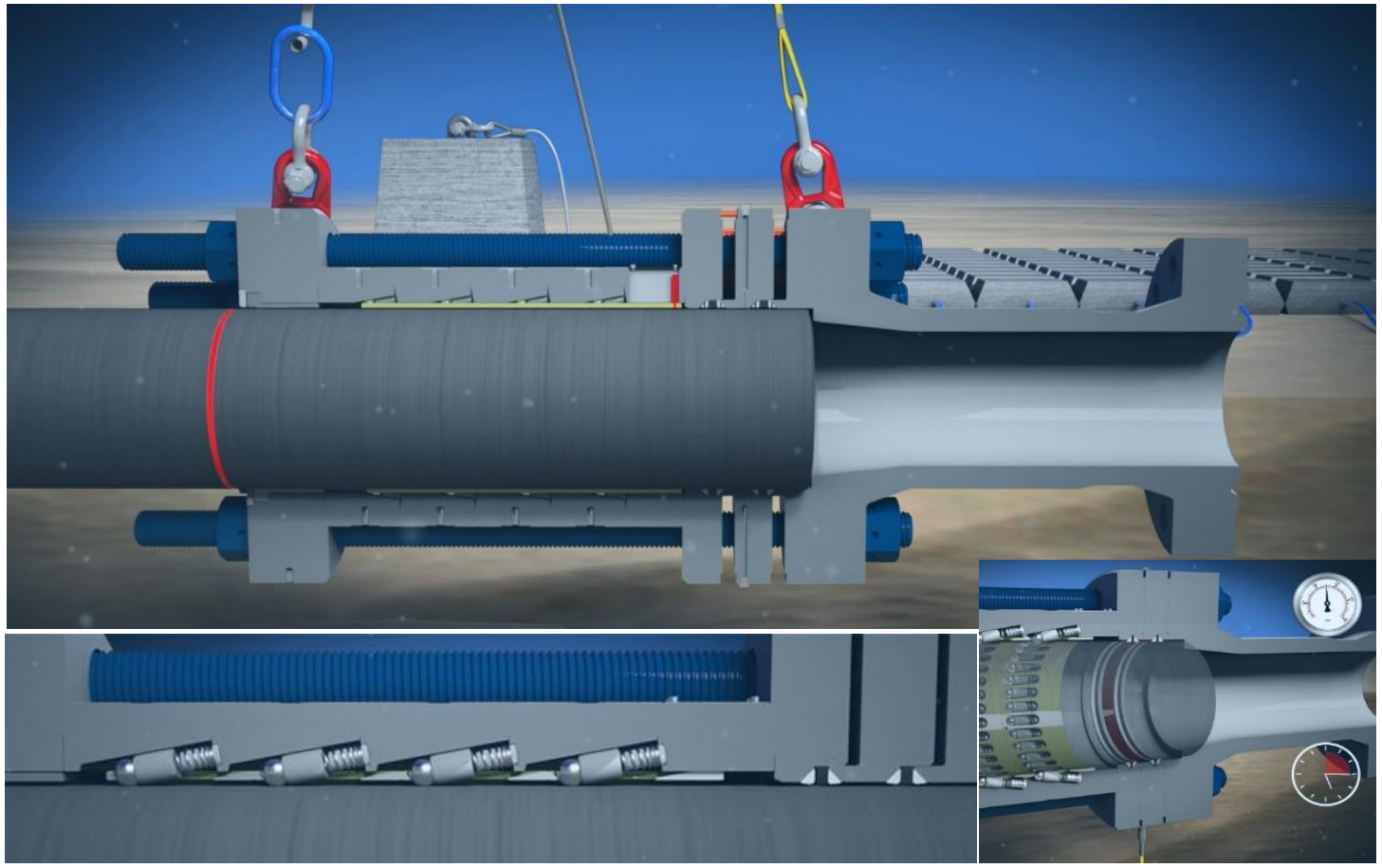
A Connector should:

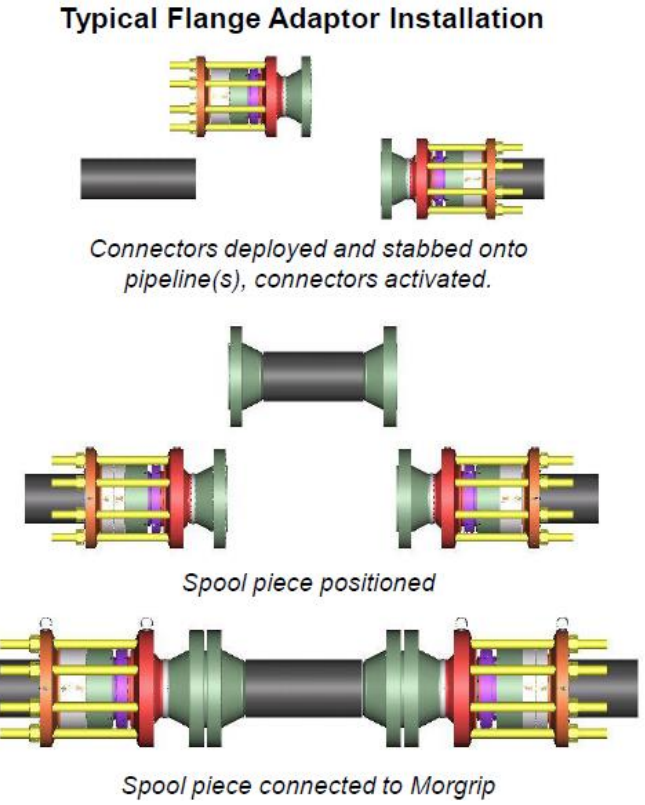
- Provide containment to suit line media, application pressure & temperatures
- Have sufficient gripping capacity to suit pressures and external loads

Wherever a pipe end needs to be cut to effect a new connection, typical uses:

- Emergency and planned repairs, piping modifications
- Tie ins and bypasses for decommissioning & Life of Field Extension

How it works



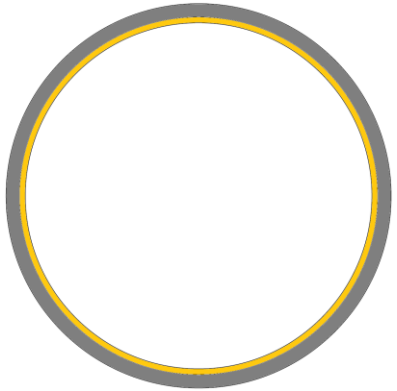

Typical Flange Adaptor Installation
Connectors deployed and stabbed onto pipeline(s), connectors activated.
Spool piece positioned
Spool piece connected to Morgrip

Clad & Lined Pipe – The Challenge

The challenge set by Chevron & Woodside

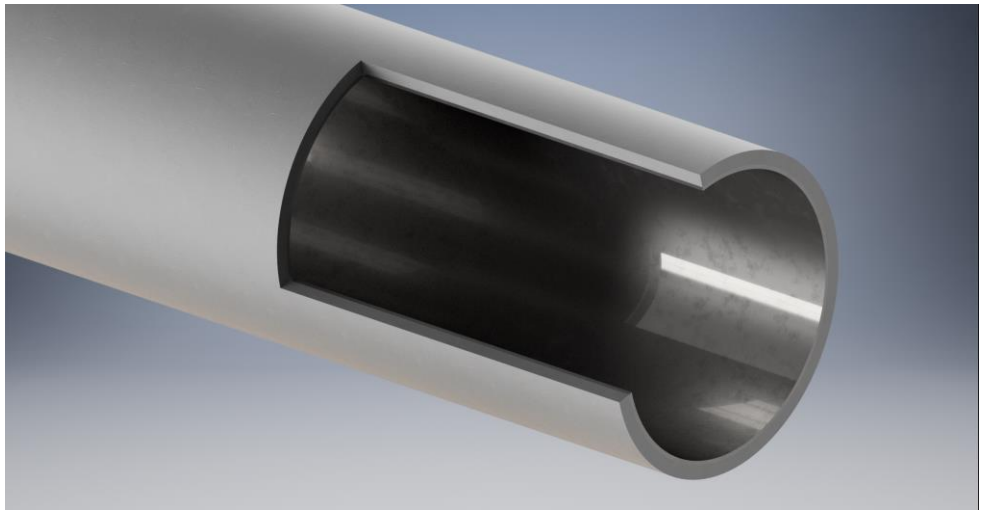
Clad & Lined Pipes are made of a parent pipe and an internal CRA barrier

- Used for pipelines containing aggressive line media – High H_2S content
- Cutting the pipe exposes the new pipe end to line media
- Parent metal and pipe to CRA interface is susceptible to corrosion



Welding repair options need:

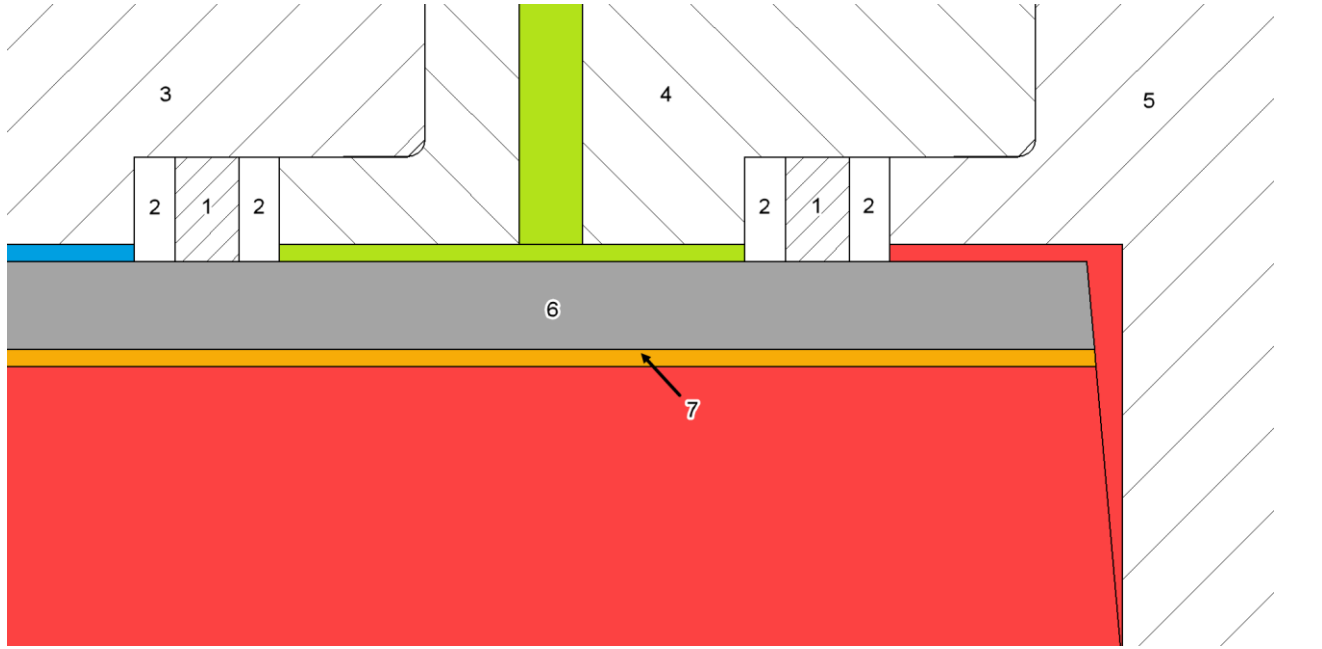
- Hyperbaric chambers & divers/remote systems
- Complex weld qualifications with dissimilar metals
- Limited availability of equipment and competence
- A change from conventional weld repair methodology



Clad & Lined Pipe – The Challenge

Conventional repair connectors seal on outside of pipe only.

Typical conventional connector seal arrangement:



1. Graphite Seals
2. Anti Extrusion Rings
3. Seal Housing
4. Twin Seal Housing
5. Transition Flange
6. Parent Pipe
7. CRA Layer

Any solution should:

- Be suitable for pigging operations
- **Protect the exposed pipe end from line media**
- Be resistant to line media for life of asset

Technology Qualification Process

Phase number	Description	How	What
1	Qualification basis - requirements	• Outlines problem, sets parameters and outlines solution	• Clad pipe, • Size & pressure range • Concept(s)
	Technology Assessment	• Identifying what's new and novel	• Main connector design proven • New seal module is Novel
2	Threat Assessment	• FMEA of new/novel • Iterative process updated for changes as project progresses	• Identify threats • Use likelihood & probability to quantify risks
	Qualification Plan	• Detail plan to address high risk threats • Redefine parameters around risks	• Identify models, testing etc that needs to be done • Update as required

Technology Qualification Process

Phase number	Description	How	What
3	Execution of Plan	• Production Unit design & manufacture	• Computational Models • Small scale/component testing • Review Full scale testing against predictions
	Performance Assessment	• Report based on project findings	• Quantify risk reduction & residual risks
Launch	NPD Launch Documentation	• Internal process	• CSS Technical and commercial documentation, training etc

- DNVGL-RP-A203 process for development of new CLiP Connector Seal
- Regular technical review carried out internally, with JIP partners and DNVGL

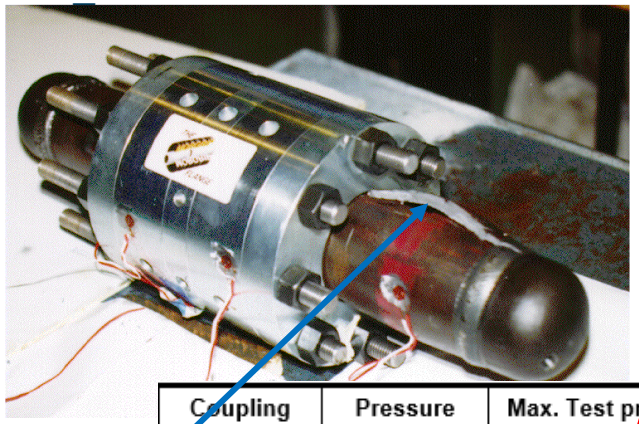
Why use DNVGL Processes

- DNVGL-RP-A203 is an established framework for new product development with a focus on developing robust solutions
- DNVGL Type Approval* is a recognized process for approval of design of pipeline repair products
- Ability to minimise “double testing” where relevant validation is present in existing DNVGL Type Approval*
- Design, Materials of Construction, FMEA, scale testing and full product testing combine to validate solutions
- Involves testing of products beyond their specified capabilities to prove high level of integrity (not just 1.5 times design pressure!)
- Requires a methodology for assessing full range of variables each application

* DNVGL Type Approval to DNVGL-ST-F101 and DNVGL-RP-F113

Scope of Technology Assessment

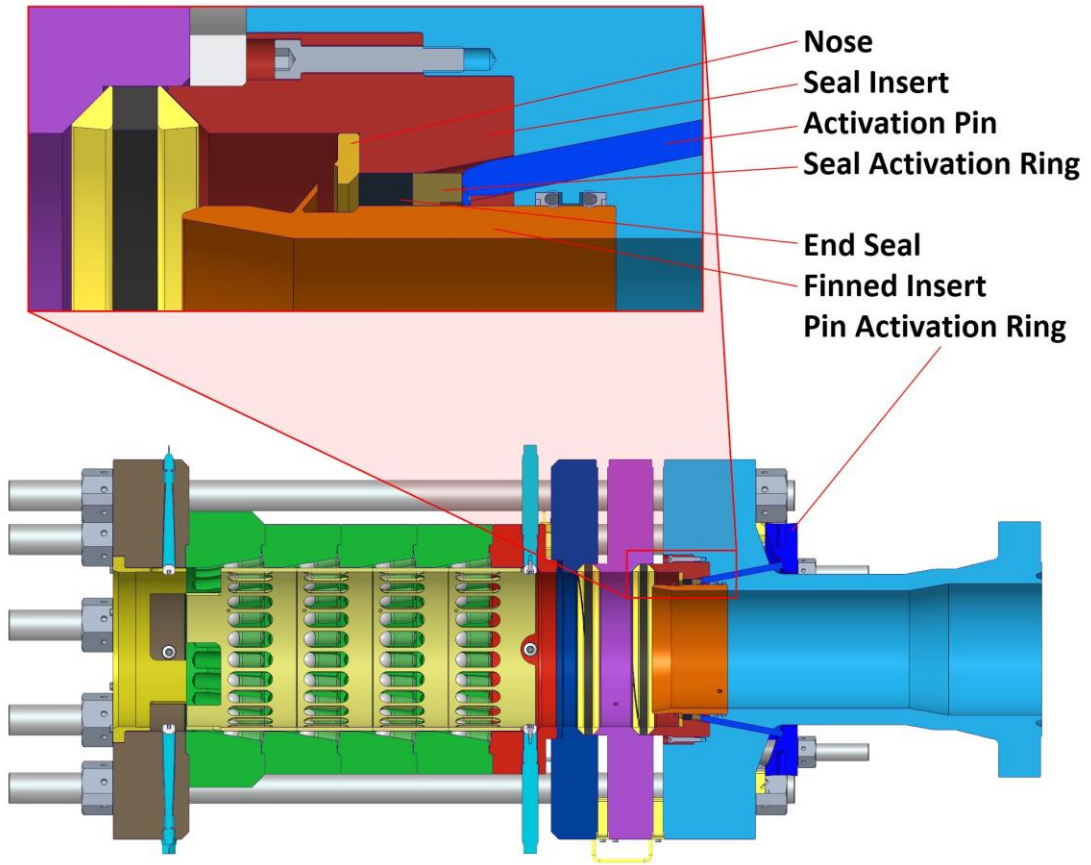
- Main connector based on DNVGL Type Approved gripping and sealing technology via **burst test, external load test, fatigue test** etc
- Focus of JIP was to validate the NEW end seal module



Test equipment capacity

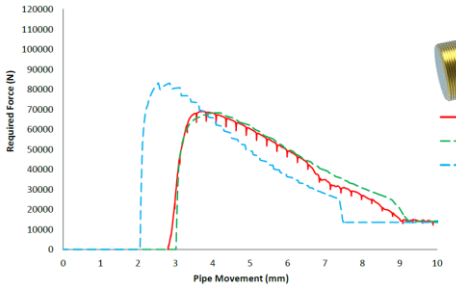
Pipe Failure

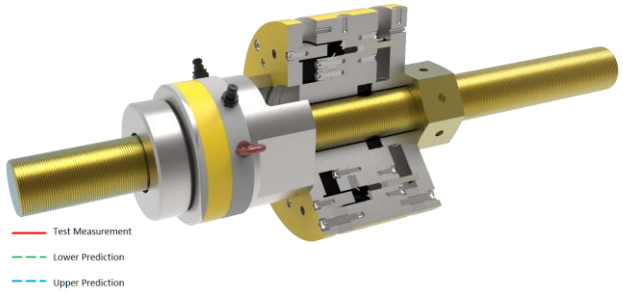
Coupling Size	Pressure Class	Max. Test pressure (bar)	Ratio of: Max. test pressure Max. working pressure
1"	900 lb	2033	13.1
3"	900 lb	1389	9.0
"6"	900 lb	1412	9.1
12"	900 lb	833	5.4



Technology Qualification Process

- Identification of key material – Alloy 625 with additional heat treatment controls
- Computer modelling of material behavior
- Small scale testing of seal module & validation of model
- Excellent performance of seal module at internal weld seam observed
- Corrosion testing of modified Alloy 625
- Full scale External Seal Test & Internal Hydrotest
- Internal Capacity Strength Test (over pressure)
- Compressive Strength Test
- Reporting for performance assessment closed out



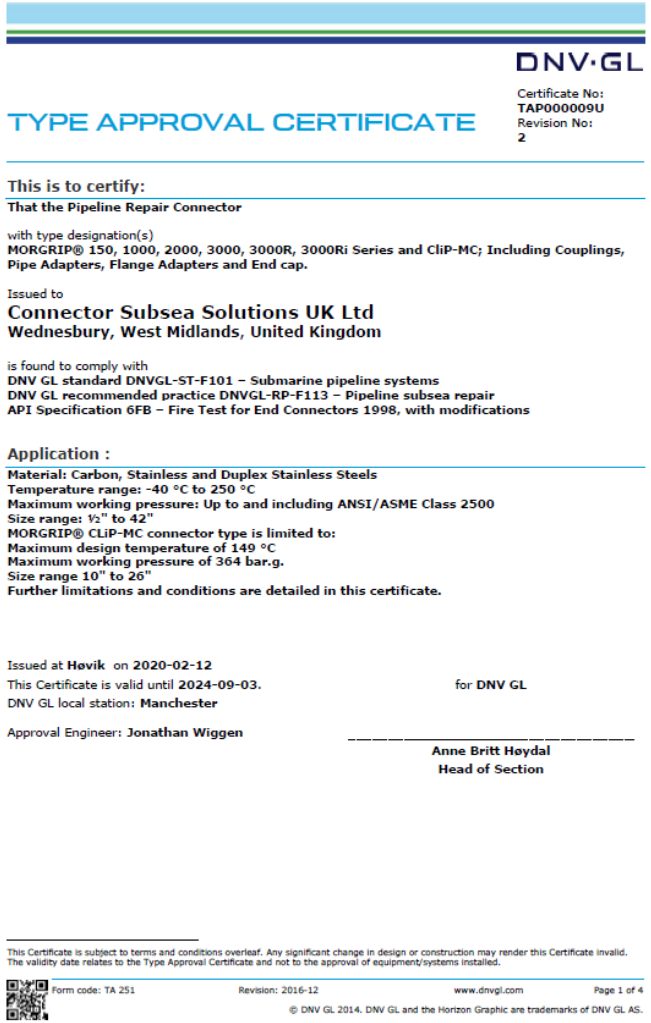


DNVGL Type Approval Awarded

For standard MORGRIP ½" to 42", 640bar(g), -40°C to 250°C for carbon, stainless & duplex steels pipes

For MORGRIP CLiP – defined by JIP partners

- Maximum design temperature of 149 °C
- Maximum working pressure of 364 bar(g)
- Size range 10" to 26"



DNV·GL

Certificate No:
TAP000009U
Revision No:
2

TYPE APPROVAL CERTIFICATE

This is to certify:

That the Pipeline Repair Connector

with type designation(s)
MORGRIP® 150, 1000, 2000, 3000, 3000R, 3000Ri Series and CliP-MC; Including Couplings, Pipe Adapters, Flange Adapters and End cap.

Issued to
Connector Subsea Solutions UK Ltd
Wednesbury, West Midlands, United Kingdom

is found to comply with
DNV GL standard DNVGL-ST-F101 – Submarine pipeline systems
DNV GL recommended practice DNVGL-RP-F113 – Pipeline subsea repair
API Specification 6FB – Fire Test for End Connectors 1998, with modifications

Application :

Material: Carbon, Stainless and Duplex Stainless Steels
Temperature range: -40 °C to 250 °C
Maximum working pressure: Up to and including ANSI/ASME Class 2500
Size range: ½" to 42"
MORGRIP® CLiP-MC connector type is limited to:
Maximum design temperature of 149 °C
Maximum working pressure of 364 bar.g.
Size range 10" to 26"
Further limitations and conditions are detailed in this certificate.

Issued at **Høvik** on **2020-02-12**
This Certificate is valid until **2024-09-03.**
DNV GL local station: **Manchester**

Approval Engineer: **Jonathan Wiggen**

for **DNV GL**

Anne Britt Høydal
Head of Section

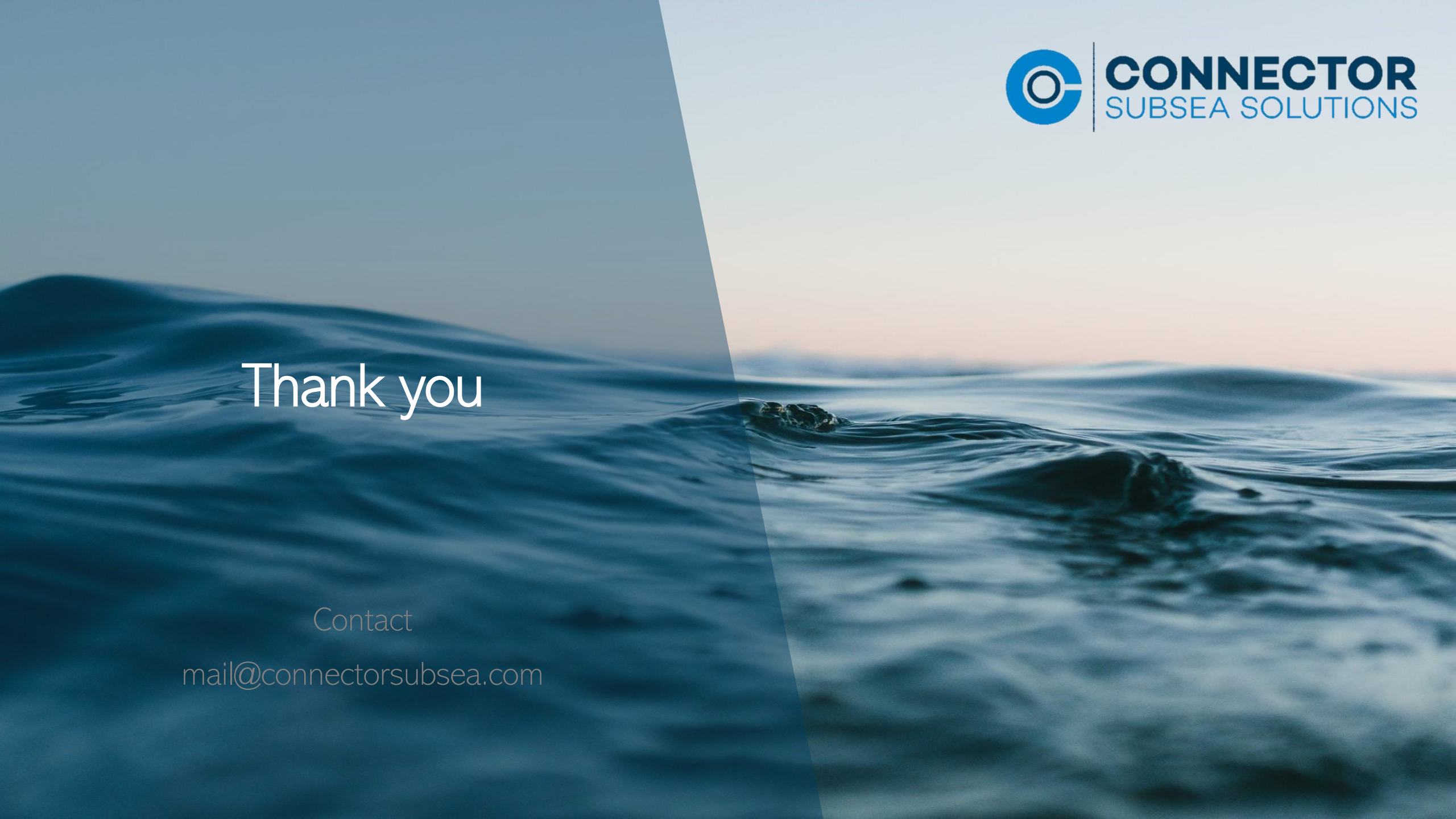
This Certificate is subject to terms and conditions overleaf. Any significant change in design or construction may render this Certificate invalid.
The validity date relates to the Type Approval Certificate and not to the approval of equipment/systems installed.

Form code: TA 251 Revision: 2016-12 www.dnvgl.com Page 1 of 4

Summary

- JIP partners help define problem, provide funding and valuable engineering input, but can limit scope (to their area of interest)
- JIP process can take time with gaps between phases – this was a 2 phase JIP
- 3rd Party Type Approval to suitable standards are an excellent means of providing assurance for a new product - always be willing to question if unsure, a good supplier will welcome this
- DNVGL-RP-A203 provides a solid framework around which to develop a product for market
- Lessons learnt: Process was longer and more complex than first expected but ultimately delivered a robust solution

What comes next… you tell us, give us your challenges!



CONNECTOR SUBSEA SOLUTIONS

Thank you

Contact

mail@connectorsubsea.com