

TYPE APPROVAL CERTIFICATE

This is to certify:**That the Pipe Couplings**

with type designation(s)
SIClamp

Issued to

Subsea Innovation Ltd
Darlington, County Durham, United Kingdom

is found to comply with
DNVGL-ST-F101 Submarine pipeline systems
DNVGL-RP-F113 Pipeline subsea repair

Application :

For use as temporary and permanent "structural repair clamp and sealing-only clamp" for carbon steel pipelines for water, oil and/or gas transport.
Conditions and limitations are given below and in reference documents.
Design to follow approved design documentation and test procedures given in the reference documents.

This Type Approval is not valid for application on DNV GL class systems.

Temperature range: -4 to +80 °C

Sizes: 8" to 44"

Issued at **Høvik** on **2018-11-29**

This Certificate is valid until **2023-11-28**.

DNV GL local station: **Aberdeen**

for **DNV GL**

Approval Engineer: **Jonathan Wiggen**

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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.



Certificate history

Certificate number	Description	Issue Date
TAP00001JG	Original DNV GL Type Approval Certificate	2018-10-11

Product description

Product	Application	Product designation
Subsea pipeline repair clamp	Carbon steel pipeline with nominal outer diameter sizes 8" to 44"	SIClamp

Design features:

- The clamp is designed to both be a leak clamp and a structural clamp for pipeline pin-hole leak and loss of pipeline cross-section strength, respectively.
- The clamp includes gripping to pipe wall outer surface at each pipeline end, providing specified structural design load capacity for full failure of the pipe cross-section inside the clamp (i.e. Structural clamp).
- The clamp features double sealing, with test port enabling back-seal test (i.e. leak clamp).
- The repair clamp can as an option filled with grout, restraining pipe wall radially within the clamp.

The Pipeline Repair Clamp comprises of several elements, which are assembled as 2-half units, brought together to create fully enclosed sealing and gripping assembly – utilised to achieve the intended purpose specific to the pipeline repair.

The Clamp is installed onto a section of client pipeline, whereby the Clamp fully encloses the pipeline upon installation.

The seals are energised using hydraulic tensioners to pre-determined values, bringing each clamp half together and subsequently compressing the seals and a seal cavity test performed once complete.

The collets are activated using hydraulic tensioners to pre-determined values and the seal cavity test is performed once more, confirming the seals are still activated as required.

The collet housings contain the collet segments and are designed with an internal taper to generate the self-locking effect, which applies a proportional grip increase to the pipeline when axial tension is applied.

The individual components or sub-assemblies are:

- 1) Clamp halves,
- 2) Radial seal arrangement,
- 3) Longitudinal seal arrangement,
- 4) Collet housing,
- 5) Collet (wedged segments with serrated teeth profile providing mechanical grip/connection to the pipeline outer surface),
- 6) Stud bolts.

Repair Clamp Design Data

The repair clamp design has been assessed based on the following data:

Parameter	Unit	Repair Clamp
Design standard	-	DNVGL-ST-F101
Recommended practise	-	DNVGL-RP-F113
Service specification	-	DNVGL-SE-0499
Test pressure	barg	1.43 x design incidental pressure
Design pressure ¹⁾	barg	Design pressure to be established through the approved design procedure, ref. D-1408-SUB-42
Design temperature ²⁾	°C	+4 to +80
Installation depth	m	Maximum 1350
H ₂ S content	ppm	Maximum 100
Seal design life ³⁾	years	25
Clamp design life ⁴⁾	-	Project specific
Clamp material	-	Clamp half: ASTM A182 F22 Collet housing: ASTM A182 F22 Collet material: ASTM A182 F22
Bolt material	-	ASTM A320-L43
Seal material	-	HNBR 65-67°A
Angle of gripping collet wedge	angle	7 deg.
Tooth height/serration pitch	mm	0.5 - 1.0
Tooth width	mm	1.0
Surface hardness of serrated segments	HV10	550-600 (Typical 2 times the surface hardness of the pipeline)

Notes:

- 1) Design pressure is in this context the incidental pressure as defined in DNVGL-ST-F101.
- 2) For temperature restriction, see details regarding sour service application in table below.
- 3) based on maximum H₂S content and temperature given above.
- 4) Subsea Innovation calculate the quantity of cathodic protection required for the Emergency Pipeline Repair Clamps during the client specified design life in accordance with DNVGL-RP-B401.

Pipeline application

Parameter	Unit	Repair Clamp
Design standard	-	DNVGL-ST-F101
Pipeline size range	-	8" to 44" outer diameter pipeline (DNVGL-ST-F101 specification)
Pipeline ovality	-	DNVGL-ST-F101
Pipeline OD tolerances	-	DNVGL-ST-F101
Pipeline WT tolerances	-	DNVGL-ST-F101
Pipeline material	-	C-Mn Steel up to Grade 450 ¹⁾
Pipeline fluid service	-	Water, Seawater, Hydrocarbon oil and / or gas, including H ₂ S. Compliant with ISO 15156. Limitations of clamp HNBR seal, for 25 years design life: I. 2.0 volume% H ₂ S in the gas phase, maximum 80°C II. 0.2 volume% H ₂ S in the gas phase, maximum 110°C III. 0.1 volume% H ₂ S in the gas phase, maximum 120°C, given that the fluid in other respects is similar to what is used in NORSOK M-710/ISO 23936-2 testing. Pipeline fluid additives must be evaluated individually for compliance with seal design.
Sour service	-	
Surface roughness	-	SA2.5 (or SA2.0)

Notes:

- 1) Application on equivalent pipe material grades such as grade up to X65 is applicable provided equivalent fabrication process and material properties.

Application/Limitation

This Type Approval certifies that the methodology of the presented design documentation meets the requirements given in specified codes as well as DNV GL's engineering judgement. This includes an assessment of possible failure modes, analysis and procedures, which reduces the risk of these failures to occur.

This Type Approval covers the design methodology only. Activities related to manufacturing are not covered by this certificate but can be covered by DNV GL product certification. A DNV GL Product Certificate can be based on this Type Approval, provided that DNV GL has been involved in the manufacturing activities as detailed in DNVGL-SE-0499 "Certification of Pipeline Components" with the requirements as specified in either DNVGL-ST-F101 or DNVGL-RP-0034.

This Certificate only relates to the design of pipeline repair clamps in the permanent works condition. The clamp performance related to installation, pipeline preparations and potential retrieval is not covered by this certificate.

1. Each repair clamp shall be hydraulically pressure tested prior to installation. The test pressure shall be specified by the purchaser and shall be typically 1.43 times the maximum design pressure (i.e. incidental pressure) of the pipeline system, unless otherwise restricted by the relevant design code. Alternative test pressure levels as specified in DNVGL-RP-F113 may be applied provided section 2.2.3 of this recommended practice is followed.
2. After installation, seal test pressure, as defined in the design manual, is to be applied via external ports to the cavity between the two seals. The test pressure shall be specified by the purchaser and shall be typically 1.50 times the max. design pressure (i.e. incidental pressure) of the pipeline system, unless otherwise restricted by the relevant design code.
3. When the clamp is used for projects as a structural clamp, where the clamp design capacity is dependent on a minimum specified collet gripping capacity, the performance of the collet segments shall be documented in the FAT, using a test pipe where the pipe section is fully split at mid-length of the clamp, with the pipe ends exposed to full bore end-cap load. The grip indentation into the pipe wall shall be inspected after the FAT to document that the grip marks are within established accept criteria with respect to indentation depth and area and with no sign of slippage.
4. The qualified design load envelope for each clamp is the characteristic load(s) multiplied with the load and resistance factors as specified in DNVGL-RP-F113 for the relevant safety class. If the safety class is unknown, safety class *High* should be applied.
5. For pipeline systems where the repair clamp seal may be exposed to explosive decompression, additional seal qualification will be needed.
6. Application on topside piping, risers and tie-in spools need to be handled through a case-by-case evaluation.
7. Testing of the repair clamp shall be on a test pipe with equivalent of conservative properties and dimensions as the actual pipeline. Preparation of the test pipe shall be by equivalent methods and tools as will be used during an actual repair campaign.
8. For each repair clamp, the design life w.r.t metal loss from external corrosion shall be established through a cathodic protection design compliant with DNVGL-RP-B401.

Type Approval documentation

The DNV GL review of the design documentation is documented in the following design verification reports (DVR's):

Document number	Revision / Date	Description
DVR-PP156674-1	02 / 2017-08-25	DNV GL Design Verification Report – Domgas 20" pipeline
DVR-PP156674-2	03 / 2017-08-30	DNV GL Design Verification Report – Jansz 30" pipeline
DVR-PP156674-3	03 / 2017-08-25	DNV GL Design Verification Report – Jansz 34" pipeline
DVR-PP156674-4	02 / 2017-08-25	DNV GL Design Verification Report – Gorgon 34" pipeline
DVR-PP156674-5	02 / 2017-08-25	DNV GL Design Verification Report – Ichthys 42" pipeline
DVR-PP156674-6	03 / 2017-08-30	DNV GL Design Verification Report – Wheatstone 44" pipeline

The design verification which the type approval is based on is based on review of the following documents:

Drawing/ Document No.	Rev. / Doc. Date	Title	For Info/ Approved	VerCom date
D-1408-SUB-42	2018-10-05	Type Approval Design Basis Document	Approved	2018-10-01
D-1408-SUB-21	24.04.2017	Collet Grip Capacity	Approved	2017-08-14
D-1408-SUB-22	09-05-2017	Collet Grip Test Procedure	Approved	2017-08-14
D-1408-SS7-06-006	-	20in End Cap Load Test - Task Plan 006	Approved	2017-03-31
D-1408-SS7-19	21.09.2016	Calculation and FEA report	Approved	2016-11-02
DI-1436-CLW-02	2015-03-12	HNBR test report with additional information given in: - email: E-1408-DNV-45 H2S - 24.04.2017 - email: E-1408-DNV-54 - 14.08.2017	Approved	2017-08-14
-	-	VerCom Cathodic Protection Design R01	Approved	2017-03-17
D-1408-SS7-06	01 / 2017-04-05	FAT procedure	Approved	2017-04-21
D-1408-SS7-40	04.04.2017	Collet Gripping Margin	Approved	2017-04-05

Documentation

Documentation for each repair clamp size that shall be available at the manufacturer:

- Design Premises
- Assembly drawing with part list
- Calculations
- Machine Drawings
- Material Specifications
- Pipeline exposure from the clamp and pressure stress calculations
- Inspection and test plan
- Test reports containing compliance with test procedures

Conditions

- Each of the repair clamp modules must be tested to full differential incidental pressure x 1.43 separately as part of or prior to the Factory Acceptance Test (FAT).
- FAT or equivalent shall document the following; the seal function of the largest possible diameter and the locking system function by teeth grip onto the pipe. The latter shall be inspected after the test and show that the teeth have given plastic indentation marks into the pipe wall. Further it shall be documented that the hardness of the tested pipe is at least equivalent to the actual pipe.
- The annulus pressure shall be monitored during actual operation to verify double seal functionality.

Tests carried out

Product Name / Identification	Reference
SI – FACTORY ACCEPTANCE TEST REPORT	D-1408-SS7-07 (2017-04-11)
Gripping Qualification	D-1408-SUB-22

Inspection of manufacturing and testing of prototype(s) has been carried out by DNV GL Aberdeen, signed as witnessed by DNV GL in the above referenced test reports.

Marking of product

For traceability to the Type Approval certificate, the final products are to be marked with:

- Manufacturers identification
- NV-stamp and/or Serial-/Part No.

Periodical assessment

The scope of the Periodical Assessment is to verify that the conditions stipulated for the Type Approval is complied with and that no alterations are made to the product design or choice of materials.

Periodical Assessment to be performed after two (2) years (Certificate Retention) and at renewal after five (5) years (Certificate Renewal).

The main elements of the Periodical Assessment are to, ref. DNVGL-SE-0499:

- Ensure that **Type Approval documentation** is available.
- Review design, materials, production process, and performance with respect to possible changes, to ensure compliance with **Type Approval documentation** and/or referenced material specifications.
- Ensure traceability between manufacturer's product marking and the DNV GL Type Approval Certificate, if relevant.

END OF CERTIFICATE