

# STANDARD FOR CERTIFICATION

No. 2.9

Type Approval Programme No. 5-792.20

## PIPE COUPLINGS

APRIL 2010

DET NORSKE VERITAS

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# FOREWORD

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The Society reserves the exclusive right to interpret, decide equivalence or make exemptions to this Standard for Certification.

This document replaces the October 2002 issue and is valid until superseded by a new revision or withdrawn.

## Main Changes

- Sec. 4 is revised with regard to preparation for and performing tightness testing, burst pressure testing as well as pull-out test.
- Sec. 5 is deleted, replaced by specific test sampling programme.
- New Sec. 6, for application in different piping systems and limitations of coupling with threaded connection.
- Updating throughout of references to standards.

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## CONTENTS

<b>1. SCOPE</b> .....	<b>4</b>	4.6	Vibration test .....	6
1.1 General .....	4	4.7	Pressure pulsation test .....	6
1.2 Objective .....	4	4.8	Fire tests .....	7
<b>2. TYPE APPROVAL</b> .....	<b>4</b>	4.9	Oxygen shock test .....	7
2.1 Procedure .....	4	4.10	Vacuum test .....	7
<b>3. DOCUMENTATION</b> .....	<b>4</b>	<b>5. SELECTION OF TEST PIECES SAMPLES</b> .....	<b>7</b>	
3.1 Drawings, specifications and information to be submitted .....	4	5.1 General .....	7	
3.2 Materials .....	4	<b>6. APPLICATION/LIMITATION</b> .....	<b>8</b>	
3.3 Design .....	4	6.1 General .....	8	
<b>4. TESTING, PROCEDURE AND REQUIREMENTS</b> .....	<b>4</b>	<b>7. MARKING</b> .....	<b>8</b>	
4.1 General .....	4	7.1 General .....	8	
4.2 Tightness test .....	5	<b>8. CERTIFICATION CONDITIONS</b> .....	<b>8</b>	
4.3 Repeated assembly test .....	5	8.1 Type Approval Certificate .....	8	
4.4 Burst pressure test .....	5	8.2 Certificate retention .....	8	
4.5 Pull-out test .....	6	<b>9. STANDARDS REFERRED TO IN THIS DOCUMENT</b> .....	<b>8</b>	

## 1. Scope

### 1.1 General

This Standard for Certification gives the requirements on which Det Norske Veritas base their type approval of pipe couplings. In general the conditions outlined in this Standard for Certification shall be fulfilled before type approval is given.

### 1.2 Objective

Type approval of pipe couplings is based upon the requirement in the relevant parts of the following DNV documents:

- Det Norske Veritas Rules for Classification of Ships Pt. 4 Ch. 6
- Det Norske Veritas Rules for High Speed, Light Craft and Naval Surface Craft Pt. 4 Ch. 6
- DNV-OS-D101 Marine and Machinery Systems and Equipment
- DNV-OS-E402 Offshore Standard for Diving Systems.

## 2. Type Approval

### 2.1 Procedure

The type approval procedure consists of the following elements:

- design assessment
- prototype testing
- certificate retention survey.

See Det Norske Veritas' Standard for Certification - No. 1.2 for the general procedures for type approval.

## 3. Documentation

### 3.1 Drawings, specifications and information to be submitted

Two copies of the following documents and information shall be submitted together with the application for type approval:

- Manufacturers catalogue, brochure, folder or equivalent with description of the product.
- Typical sectional drawing(s) with all dimensions necessary for strength calculations and possible reference to recognized standards.
- Complete specification of material used in the different metallic parts of the couplings, or reference to recognized national/international material standard. Sufficient information on possible non-metallic materials shall be given, enabling identification of the material.
- Documentation of test results from prototype testing as required by this Standard for Certification. Copies of test reports signed by responsible person may be accepted.

Responsible person in this relation can be a surveyor from DNV or a responsible person at an independent testing laboratory. The technical manager or, if the manufacturer has a certified QA-system, the QA-manager may sign the test reports.

### 3.2 Materials

#### 3.2.1 General requirements

The materials used in the coupling parts shall comply with the requirements in this Standard for Certification and/or to Det Norske Veritas Rules for Classification of Ships. Material may also be specified to comply with recognized national/interna-

tional material standards such as ASTM, BS, DIN, EN, ISO etc. taking into account possible limitations or additional requirements given in the Rules.

#### 3.2.2 Elevated temperatures

The maximum pressure for which the couplings are type approved is defined as maximum allowable pressure for continuous service at +20°C. For elevated temperatures the maximum allowable pressure may have to be reduced dependent on the material quality. When no documentation of the mechanical properties at elevated temperatures is available, the pressure will be reduced according to Table 3-1.

Temperature	Carbon steels, unalloyed	Low alloyed steels	Stainless steels
20°C	1,00	1,00	1,00
50°C	1,00	1,00	0,95
100°C	1,00	1,00	0,85
150°C	0,89	0,93	0,77
200°C	0,81	0,87	0,71
250°C	0,72	0,81	0,67
300°C	0,65	0,75	0,63
350°C	0,59	0,69	0,60
400°C	0,54	0,63	0,58
450°C	0,50	0,57	0,57
500°C	N/A	0,52	0,56
550°C	N/A	N/A	0,55
600°C	N/A	N/A	0,50

For practical reasons the following maximum metal temperatures will be accepted concerning type approval:

Carbon steels, unalloyed: +450°C

Low alloyed Mo-steels: +500°C

Low alloyed CrMo-steels: +550°C

Stainless steels 304L and 316L: +400°C

Stainless steels 304, 316 and 321: +600°C.

If higher utilisation of the material is wanted, the mechanical properties of the material at elevated temperatures have to be documented.

### 3.3 Design

#### 3.3.1 General

The strength of the couplings will be evaluated according to the requirements in this Standard for Certification and Det Norske Veritas Rules for Classification of Ships. The type approval will mainly be based on results from tests performed on samples of the actual couplings. Finite Element analysis or experimental stress analysis or equivalent may in some cases be considered as a substitute to some of the required testing.

## 4. Testing, procedure and requirements

### 4.1 General

Where not specified, the length of pipes to be connected by means of the joint to be tested is to be at least five times the pipe diameter. Before assembling the joint, conformity of components to the design requirements, is to be verified. In all cases the assembly of the joint shall be carried out as for normal working conditions. No adjustment operations on the joint assembly, other than that specified by the manufacturer, are permitted during the test.

A listing of the required tests is given in the below Table 4-1.

Tests		Types of coupling			Notes
		Compression couplings and pipe unions	Slip-on Joints		
			Grip type, Machine grooved types and other axial restraining couplings	Slip type	
1	Leakage test (4.2)	X	X	X	
2	Repeated assembly test (4.3)	X	X	-	
3	Burst pressure test (4.4)	X	X	X	*
4	Pullout test (4.5)	X	X	-	
5	Vibration test (4.6)	X	X	-	
6	Pressure pulsation test (4.7)	X	X	-	
7	Fire test (4.8)	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	For applications listed in 4.8
8	Oxygen shock test (4.9)	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	For oxygen only
9	Vacuum test (4.10)	X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>	For suction lines only

X: Test required  
 -: Test not required  
<sup>1)</sup> Application dependent  
 \* The burst test is to be witnessed by DNV when performed at manufacturer's locations.

Other test procedures may be suggested by the manufacturer, and may be accepted provided they are considered to fulfil the intentions of this Standard for Certification, or perhaps deemed even more demanding.

The test report shall at least contain the following information:

- name of the testing laboratory, and testing date
- test equipment and calibration status
- description of the product(s) tested
- a short description of the testing procedure
- test results and possible test events
- maximum design pressure
- test temperature
- temperature range (maximum and minimum temperature)
- reference to design Rules, Codes, Standards, or other Regulations
- field of applications and possible limitations
- welding procedure specifications with qualification test if the couplings are welded
- brazing/swaging specifications if the couplings are brazed or swaged
- marking of product.

#### 4.1.1 Material in the test samples

When couplings of the same basic design are made in many different sizes and material alternatives without changes in the wall thickness etc. the coupling having the lowest mechanical strength shall be selected for testing.

#### 4.1.2 Assembly of couplings

The couplings shall be assembled according to the manufacturer's written instructions and with the pipe size and material quality appropriate to the design of the couplings.

Where not specified in the test procedures, the length of pipes to be connected by means of the couplings shall be at least five times the pipe diameter.

No adjustment operations on the coupling assemblies, other than specified by the manufacturer, are permitted during the test.

#### 4.2 Tightness test

In order to ensure correct assembly and tightness of the couplings, all couplings shall be subjected to a tightness test as follows.

- a) The coupling assembly shall be filled with test fluid and purged for air. The assembly shall then be pressurised to

1.5 times the design pressure. This test pressure shall be attained within a period of not less than 15 seconds and not more than 60 seconds. The pressure is then to be retained for a minimum period of 5 minutes.

- b) For compression couplings a static gas pressure test is to be carried out to demonstrate the integrity of the coupling assembly for tightness under the influence of gaseous media. The pressure is to be raised to the design pressure of the coupling or 70 bar, whichever is less. This test pressure is to be retained for a minimum of 5 minutes.

In the event where there is a drop in pressure or there is visual indication of leakage, the test shall be repeated for 3 test pieces.

If during the repeat test, one test piece fails, the test shall be regarded as failed.

#### 4.3 Repeated assembly test

The couplings are to be assembled and disassembled 10 times according to manufacturer's instructions. The couplings shall be tested for leakage according to procedures in section 4.2.

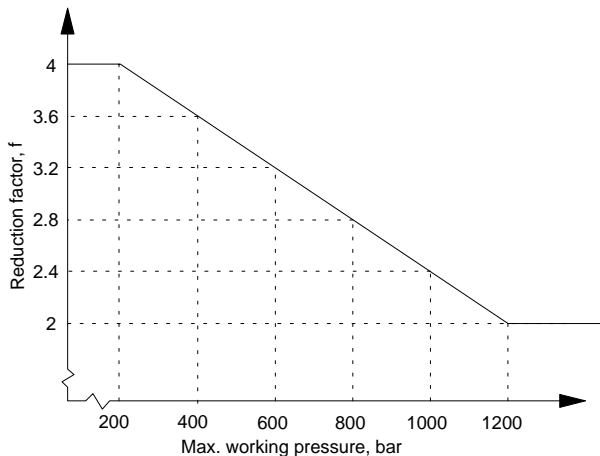
#### 4.4 Burst pressure test

The test assembly may consist of a piece of tubing of a length of at least 5 times outside diameter of the pipe, and with the couplings to be tested fitted on each end. The tubing shall be strong enough to resist the specified burst pressure without failure. One end shall be unsupported and blinded; the other end shall be connected to a pressure source having sufficient pressure range for this test.

The test rig shall be equipped with calibrated pressure/time recording instruments with sufficient range of recording. The test shall be performed in presence of a DNV Surveyor, which also shall sign the test report.

The test assembly shall be filled with water or other suitable test medium, and care shall be taken that all air is purged before the assembly is pressurized. The pressure shall be raised slowly in steps up to the calculated minimum burst pressure, giving enough time to check for leakage, and the pressure shall be held at the calculated burst pressure for at least 5 minutes. At manufacturer's option, the test pressure may then be raised further till burst occurs. Obtained burst pressure shall be at least 4 times maximum allowable working pressure. The couplings may have small visible deformations when under calculated burst pressure, but no leakage or visible cracks are permitted.

Required burst pressure of 4 times maximum allowable working pressure may be reduced according to the curve in Fig. 4-1 when the working pressures are above 200 bar.



**Figure 4-1**  
**Reduction of safety factor for burst pressure for high working pressures**

#### 4.5 Pull-out test

In order to determine the ability of a mechanical joint assembly to withstand axial load likely to be encountered in service without the connecting pipe from becoming detached, following pull-out test is to be carried out:

Pipe length of suitable size is to be fitted to each end of the mechanical joint assembly test specimen. The test specimen is to be pressurized to design pressure, imposing an axial load on the specimen. When the pressure is attained, an additional axial load shall be imposed with a value calculated by the following formula:

$$L = \frac{\pi}{4} \times D^2 \times p$$

Where:

D = tube outside diameter.

P = maximum allowable working pressure in N/mm<sup>2</sup>.

L = applied axial load in N.

The pressure and axial load are to be maintained for a period of 5 minutes.

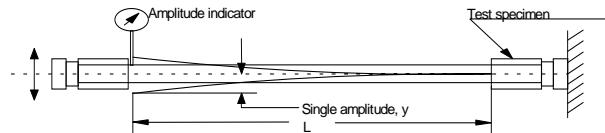
During the test, pressure is to be monitored and relative movement between the joint assembly and the pipe measured.

The mechanical joint assembly is to be visually examined for drop in pressure and signs of leakage or damage.

There are to be no movement between mechanical joint assembly and the connecting pipe, and no signs of leakage or damage.

#### 4.6 Vibration test

The vibration test (4.6) and the pressure pulsation test (4.7) are to be carried out simultaneously for compression couplings and pipe unions. A fatigue testing machine of cantilever beam, reversed bending type may be used, and the arrangement may be as shown in Fig. 4-2.



**Figure 4-2**  
**Test assembly, vibration testing**

The test assembly may consist of a tube of a length of about 16 times outside diameter of tube, and with a coupling fitted at each end. The vibration amplitude shall be within  $\pm 5\%$  of the value calculated from the following formulae:

$$y = \frac{2 \times S \times L^2}{3 \times E \times D}$$

where:

y = single amplitude (see Fig. 4-2), mm.

L = gauge length of assembly, mm (see Fig. 4-2).

S = allowable bending stress in kN/mm<sup>2</sup> based on 0.25 of the tube material yield strength taken from the material standard, or 0.25 of the 0.2% proof stress of the tube material taken from the material standard.

E = modulus of elasticity for the tube material (for mild steel: 210 kN/mm<sup>2</sup>).

D = outside diameter of the tube, mm.

It will be permitted to re-tighten the coupling once during the first 1000 cycles of the vibration testing due to possible bedding-in of the couplings.

The coupling assembly is to be filled with test fluid, de-aerated and pressurised to the design pressure of the joint.

The couplings shall be tested with a frequency 20 – 50 Hz. They shall not leak or in other ways be damaged before 10<sup>7</sup> cycles are reached.

For grip type and machine grooved type joints the same rig can be used, but the test specimen shall connect two lengths of pipes, one length to be max. 200 mm long and rigidly fixed. The other tube, 1 meter long, shall be connected to the vibrating element of the rig.

The assembly shall be filled with test fluid, de-aerated and pressurised to the design pressure of the joint.

The preliminary angle of deflection of the pipe axis is to be equal to the maximum angle of deflection as recommended by the manufacturer. The amplitude is to be measured at 1 m distance from the centre line of the joint assembly at the free pipe end connected to the rotating element of the rig. The parameters of testing are to be as indicated below and to be carried out on the same assembly:

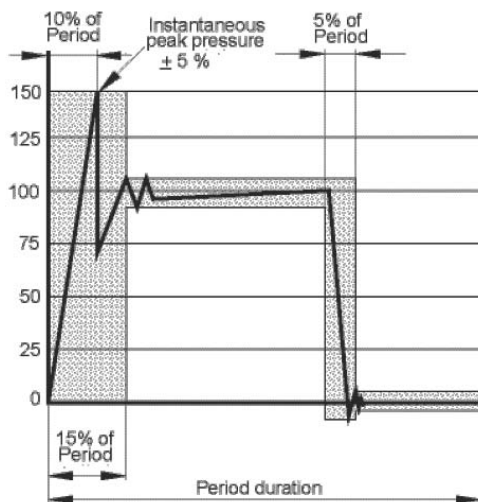
Number of cycles	Amplitude, mm	Frequency, Hz
3 000 000	$\pm 0.06$	100
3 000 000	$\pm 0.5$	45
3 000 000	$\pm 1.5$	10

#### 4.7 Pressure pulsation test

The vibration test (4.6) and the pressure pulsation test (4.7) are to be carried out simultaneously for compression couplings and pipe unions. The test rig shall be equipped with calibrated pressure/time recording instruments with sufficient range of

recording. The assembly shall be connected to a source able to give pressure impulses with a cycle according to Fig. 3, at a rate from 30 to 100 cycles/minute (0.5 Hz to 1.7 Hz). The equipment shall be able to give pressure impulses that rises the pressure from zero bar gauge to 150% of rated working pressure, damped down to rated working pressure within 15% of the time of a full cycle, (see Fig. 3).

The rated working pressure shall be kept about constant in 35% to 40% of a full cycle, and is then brought down to zero bar within about 5% of a full cycle. The assembly shall be subject to 500.000 pressure pulse cycles, and shall show no signs of leakage or other damages. The test assembly may be corresponding to the assembly used for vibration testing, and the vibration test and the pressure pulsation test may be performed simultaneously if found convenient for all kinds of couplings.



**Figure 4-3**  
 Pressure impulse curve

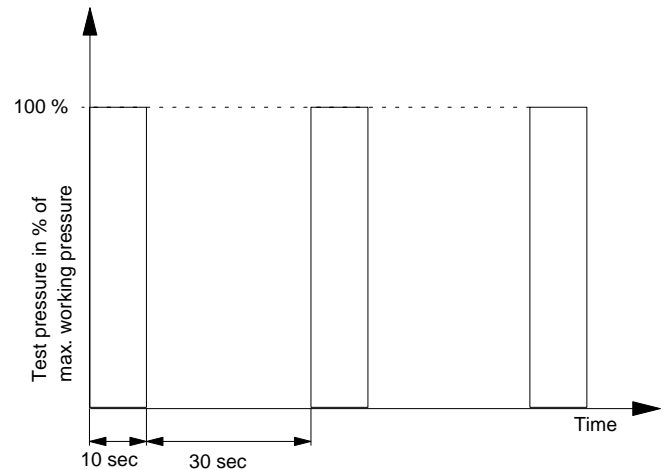
#### 4.8 Fire tests

Couplings shall be fire tested when they are to be type approved for: Systems referred to in Det Norske Veritas Rules for Classification of Ships Pt. 4 Ch. 6.

When they contain elements that may disintegrate or in other ways be rendered ineffective by heat. Test procedures shall be in accordance with ISO 19921:2005 and ISO 19922:2005.

#### 4.9 Oxygen shock test

Couplings are to be oxygen shock tested when they are to be type approved for systems having an oxygen content by volume of more than 25%. A minimum of 3 couplings shall be tested. In case the couplings are manufactured in a big range of sizes, where all the sizes are of same basic design, one small, one medium and one of the bigger sizes shall be selected. The test is to be performed by quick opening of a ball valve producing a shock wave that moves through a copper tube into the test specimen. The test medium shall be oxygen of normal industrial grade pre-heated to +60°C. The line shall be flushed with oxygen before the test commences in order to remove as much air as possible. The pre-heater must be switched on for sufficient time ahead in order to ensure that all the oxygen has reached the required temperature before the testing starts. The test samples shall be subjected to 20 shocks of pressure increase from atmospheric pressure to maximum design pressure.



**Figure 4-4**  
 Pressure test curve for oxygen shock test

The full oxygen pressure, with refill if necessary, shall act on the test samples for 10 seconds, and the time between each shock shall be 30 seconds. See Fig. 4.

NOTE! This test is considered to be dangerous to personnel, as explosive fire may occur in the system. Strict safety precautions shall therefore be taken, and it is recommended that the test is performed in a special container without any personnel inside the container during the testing.

A test procedure as described in ISO 2503 or equivalent will be accepted.

#### 4.10 Vacuum test

Couplings that are to be type approved for systems exposed to vacuum shall be able to pass a minimum static gas pressure (vacuum) test. The test assembly may be as described in section 4.4 burst pressure test with the exception that the tube may be a standard tube normally used with the couplings. 3 test assemblies of same size are to be leakage tested according to the procedure in section 4.2 leakage test.

When the couplings are manufactured in a range of sizes that are of same basic design, 3 couplings from the medium size range are to be selected. The couplings are to be thoroughly degreased with a degreasing agent not harmful to the material in the couplings. A pressure of 300 mbara shall be applied and the test assembly shall then be isolated from the vacuum pump. The pressure rise during 15 minutes after the couplings were isolated from the vacuum pump shall be maximum 30 mbar in any of the test assemblies.

### 5. Selection of test pieces samples

#### 5.1 General

For each test (except 4.2) the smallest and biggest size of the range of couplings shall in all cases be tested.

The sizes in between the biggest and the smallest will be qualified according to the following procedure:

When a coupling of a given nominal bore (DN) is tested, other couplings falling in the range DN to 2xDN (both inclusive) are considered qualified.

In some cases where the size range is very extensive, or the design of the couplings varies within the range, DNV may extend the number and sizes of test pieces.

When couplings are manufactured with different configurations such as elbows, straight unions, crosses or tees, testing of an elbow will in general qualify all other configurations with

the same bores and pressure ratings.

## 6. Application/limitation

### 6.1 General

For application of couplings in different piping systems, see DNV rules for classification of ships Part 4 Chapter 6 Sec. 6 Table E3 and Table E4.

For limitations of couplings with threaded connections, see DNV rules for classification of ships Part 4 Chapter 6 Sec. 6 E200.

## 7. Marking

### 7.1 General

Each coupling shall be clearly marked for identification. The identification marking shall be located in low stressed areas, and shall as a minimum include the following:

- manufacturer's name or trade mark
- type designation
- arrow to indicate direction of flow on one-way-flow couplings.

The areas suitable for marking may be rather limited. Det Norske Veritas will therefore accept that in such cases only the coupling body is marked when limited space makes it impossible to mark other parts of the coupling.

Only original part and internals shall be used in order to maintain the approval, and where possible Det Norske Veritas recommend that also small parts are given some sort of marking that may ease the identification of this parts. When possible the following marking shall be added:

- size
- max design pressure or pressure class.

Additional marking may be required by applicable standards or at the manufacturer's option. The actual marking performed is an important information in connection with the type approval. Information on how the marking is applied on the products and the design of the marking shall be submitted together with the application for type approval.

## 8. Certification Conditions

### 8.1 Type Approval Certificate

When the design assessment and prototype testing are successfully completed and the documentation has been examined a type approval certificate will be issued and normally given a validity period of 4 years.

### 8.2 Certificate retention

The manufacturer/holder of the certificate has to apply in writing for renewal of his certificate(s). For retention and renewal of the type approval, a DNV Surveyor shall perform a survey every second year to verify that the conditions for the type approval are complied with and to witness testing as described in the type approval certificate.

## 9. Standards referred to in this document

- BS 4368-4 Metallic tube connectors for fluid power and general use. Specification for type test requirements.
- ISO 19921:2005: Ships and marine technology - Fire resistance of metallic components with resilient and elastomeric seals - Test methods.
- ISO 19922:2005: Ships and marine technology - Fire resistance of metallic components with resilient and elastomeric seals - Requirements imposed on the test bench.
- ISO 2503 Gas welding equipment. Pressure regulators for gas cylinders used in welding, cutting and allied processes up to 300 bar.