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**Metallic tube connections for fluid  
power and general use — Test  
methods for hydraulic fluid power  
connections**

*Raccords de tubes métalliques pour transmissions hydrauliques et  
pneumatiques et applications générales — Méthodes d'essai pour  
raccords pour transmissions hydrauliques*

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# Contents

	Page
Foreword .....	v
Introduction .....	vi
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
<b>4 General requirements</b> .....	<b>2</b>
4.1 Test assemblies .....	2
4.2 Test equipment .....	5
4.2.1 Test block .....	5
4.2.2 Test seals .....	5
4.3 Procedure .....	5
4.3.1 Thread lubrication .....	5
4.3.2 Torque .....	6
4.3.3 Temperature .....	6
4.4 Test report .....	6
<b>5 Repeated assembly test</b> .....	<b>6</b>
5.1 Principle .....	6
5.2 Procedure .....	6
5.3 Re-use of components .....	6
<b>6 Leakage test</b> .....	<b>7</b>
6.1 Principle .....	7
6.2 Procedure .....	7
6.3 Re-use of components .....	7
<b>7 Proof test</b> .....	<b>8</b>
7.1 Principle .....	8
7.2 Procedure .....	8
7.3 Re-use of components .....	8
<b>8 Burst test</b> .....	<b>9</b>
8.1 Principle .....	9
8.2 Procedure .....	9
8.3 Re-use of components .....	9
<b>9 Cyclic endurance test</b> .....	<b>9</b>
9.1 Principle .....	9
9.2 Procedure .....	9
9.3 Re-use of components .....	9
<b>10 Vacuum test</b> .....	<b>10</b>
10.1 Principle .....	10
10.2 Procedure .....	10
10.3 Re-use of components .....	10
<b>11 Overtightening test</b> .....	<b>10</b>
11.1 Principle .....	10
11.2 Test equipment .....	11
11.3 Procedure .....	11
11.4 Re-use of components .....	11
<b>12 Vibration test</b> .....	<b>11</b>
12.1 Principle .....	11
12.2 Procedure .....	11
12.3 Re-use of components .....	14
<b>13 Cyclic endurance (impulse) test with vibration</b> .....	<b>14</b>

# ISO 19879:2021(E)

13.1	Principle.....	14
13.2	Procedure.....	14
13.3	Re-use of components .....	15
<b>14</b>	<b>Identification statement</b> (Reference to this document).....	<b>15</b>
	<b>Annex A</b> (informative) <b>Typical test data form</b> .....	<b>16</b>
	<b>Bibliography</b> .....	<b>19</b>

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 4, *Connectors and similar products and components*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 459/SC 10, *Steel tubes, and iron and steel fittings*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 19879:2010), which has been technically revised.

The main changes compared to the previous edition are as follows:

- clarification of the language used to describe the connector end, and of the proper method for selecting tubes for test assemblies;
- minor changes to [10.1](#), [10.2](#) ([Table 7](#)) and [12.2.2](#).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure within an enclosed circuit. It is suggested that components be designed to meet these requirements under varying conditions. Testing of components to meet performance requirements provides a basis of assurance for determining design application and for checking component conformance with the stated requirements.

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# Metallic tube connections for fluid power and general use — Test methods for hydraulic fluid power connections

## 1 Scope

This document specifies uniform methods for the testing and performance evaluation of metallic tube connections, stud ends for ports and flange connections for use in hydraulic fluid power applications. This document does not apply to the testing of hydraulic quick-action couplings, which is covered by ISO 18869.

Tests outlined in this document are independent of each other and document the method to follow for each test. See the appropriate component International Standard for indications of which tests to conduct and for performance criteria.

For qualification of the connector, the minimum number of samples specified in this document is tested, unless otherwise specified in the relevant connector standard or as agreed upon by the manufacturer and the user.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 48-2, *Rubber, vulcanized or thermoplastic — Determination of hardness — Part 2: Hardness between 10 IRHD and 100 IRHD*

ISO 3448, *Industrial liquid lubricants — ISO viscosity classification*

ISO 3601-3, *Fluid power systems — O-rings — Part 3: Quality acceptance criteria*

ISO 5598, *Fluid power systems and components — Vocabulary*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method*

ISO 6605, *Hydraulic fluid power — Test methods for hoses and hose assemblies*

ISO 6743-4, *Lubricants, industrial oils and related products (class L) — Classification — Part 4: Family H (Hydraulic systems)*

ISO 10763, *Hydraulic fluid power — Plain-end, seamless and welded precision steel tubes — Dimensions and nominal working pressures*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

## 4 General requirements

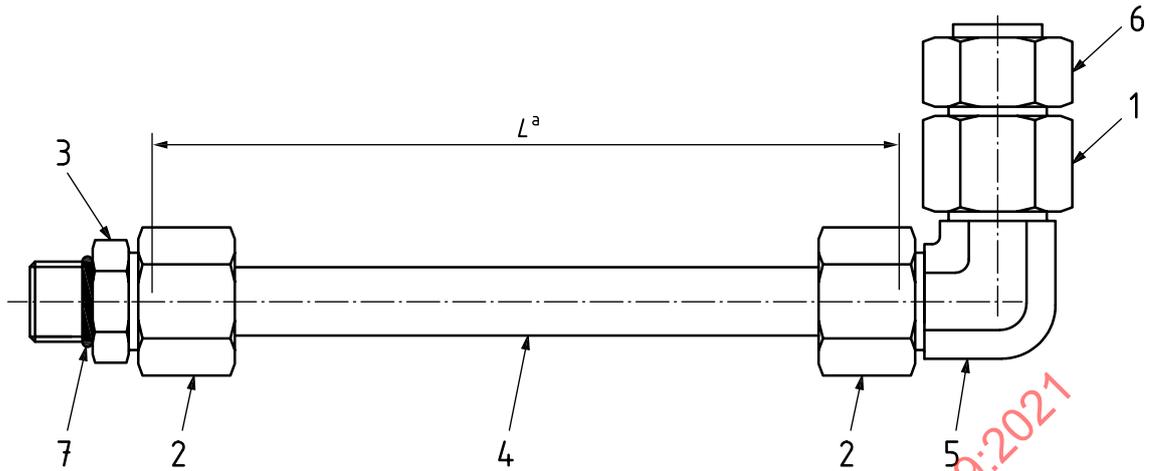
**WARNING** — Some of the tests described in this document are considered hazardous. It is, therefore, essential that, in conducting these tests, all appropriate safety precautions be strictly adhered to. Attention is drawn to the danger of burst, fine jets (which can penetrate the skin) and energy release of expanding gases. To reduce the hazard of energy release, bleed air out of test specimens prior to pressure testing. Tests shall be set up and performed by properly trained personnel, utilizing appropriate personal protective equipment (PPE).

### 4.1 Test assemblies

All components tested shall be in the final form, including annealed nuts, as required for brazed components. Unless otherwise specified in the respective connector standard, Type 1 test assemblies shall be as shown in [Figure 1](#) for tube connections, and Type 2 test assemblies shall be as shown in [Figure 2](#) for male stud ends. Alternatively, in order to test the connector to its full capability, use of the metallic tube may be omitted for burst and cyclic endurance tests, and different configurations with similar capability may be combined in a test assembly Type 3, as shown in [Figure 3](#). Type 4 test assemblies for flange connectors shall be as shown in [Figure 4](#). Test assemblies shall conform to the relevant requirements given in [Table 1](#).

**Table 1 — Requirements for test assemblies**

Part code	Part name	Description and further information
A	Straight stud connector	The type of stud end, tube-connector end and sealing method is optional but shall be recorded in the test report.
B	Metallic tube	The required tube wall thickness shall be selected according to the working pressure rating of the respective connector. The working pressure of the tube in accordance with ISO 10763 shall be equal to or slightly greater than the working pressure of the respective connector. The length of the tube shall be five times the tube outside diameter plus 50 mm.
C	Shaped connector, with swivel, if applicable	—
D	Blanking end (cap or plug)	—
E	Shaped connector with adjustable stud end.	—
F	Flange connector	—
G	Sealing	e.g. O-ring.

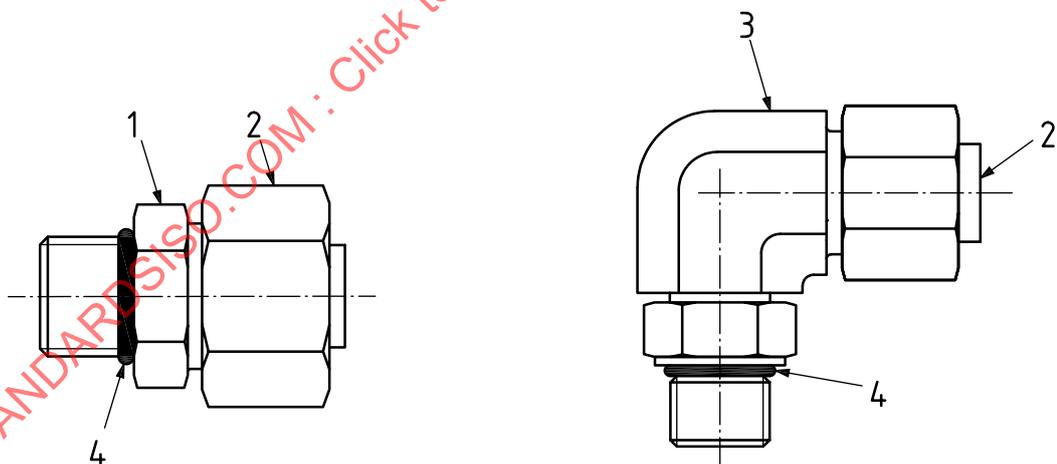


**Key**

- 1 swivel nut
- 2 tube nut
- 3 straight stud connector
- 4 metallic tube
- 5 shaped connector
- 6 blanking end (cap or plug)
- 7 sealing, e.g. O-ring

<sup>a</sup>  $L = 5 \times \text{the tube OD (in millimetres)} + 50 \text{ mm.}$

**Figure 1 — Typical test assembly for tube connection — Type 1**



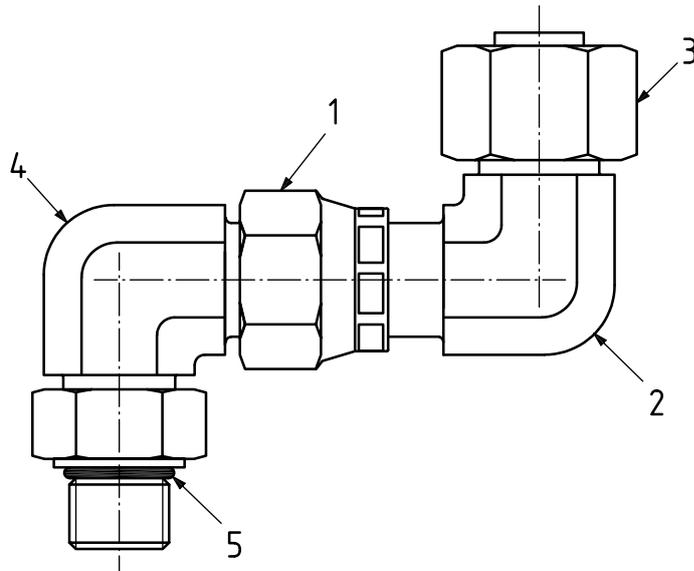
**a) Non-adjustable stud end connection**

**b) Adjustable stud end connection, with shaped connector, if applicable**

**Key**

- 1 straight stud connector
- 2 blanking end (cap or plug)
- 3 shaped connector with adjustable stud end
- 4 sealing, e.g. O-ring

**Figure 2 — Typical test assembly for stud end — Type 2**

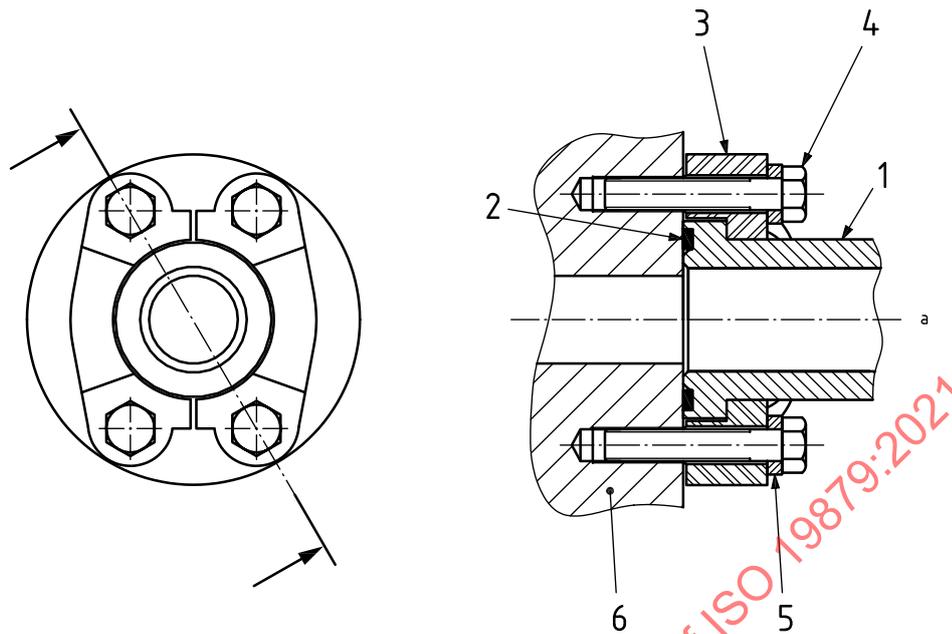


**Key**

- 1 swivel nut
- 2 shaped connector with swivel
- 3 blanking end (cap or plug)
- 4 shaped connector with adjustable stud end
- 5 sealing, e.g. O-ring

**Figure 3 — Typical test assembly without tube — Type 3**

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#### Key

- 1 flange connector
- 2 Sealing, e.g. O-ring
- 3 split-flange clamp
- 4 screw
- 5 washer
- 6 test block
- a This end capped or plugged.

Figure 4 — Typical test assembly for flange connectors — Type 4

## 4.2 Test equipment

### 4.2.1 Test block

Test blocks shall be unplated and have a minimum hardness of 35 HRC in accordance with ISO 6508-1. For a test block with multiple ports, the distance between the centrelines of test ports shall be a minimum of 1,5 times the port diameter. The distance between the port centreline and the edge of the test block shall be a minimum of 1 times the port diameter.

### 4.2.2 Test seals

For all tests, except for the overtightening test and unless otherwise specified, seals shall be nitrile (NBR) rubber with a hardness of  $(90 \pm 5)$  IHRD when measured in accordance with ISO 48-2. Seals shall conform to their respective dimensional requirements, and O-rings shall meet or exceed the quality requirements for grade N (general purpose) of ISO 3601-3, if applicable.

## 4.3 Procedure

### 4.3.1 Thread lubrication

For all tests, on connectors made of carbon steel and for testing only, threads and contact surfaces shall be lubricated prior to application of torque using a hydraulic fluid with a viscosity of ISO VG 32 in

accordance with ISO 3448. For connectors made of materials other than carbon steel, the manufacturer's recommendation for thread lubrication shall be followed.

**4.3.2 Torque**

For all tests, except the repeated assembly and overtightening tests, tube connections and stud ends shall be tested at the required minimum torques or number of hex flats or turns from finger-tight position given in the respective connector standard, if specified. Otherwise, they shall be tested at the minimum torque values or number of hex flats or turns from finger-tight position supplied by the manufacturer. For test assembly, type 2 and type 3 adjustable stud torques shall be applied after being backed out one full turn from finger-tight, in order to test correctly the worst possible actual assembly conditions.

**4.3.3 Temperature**

For all tests, the temperature of the hydraulic fluid shall be between 15 °C and 80 °C, unless otherwise specified in the respective connector standard.

**4.4 Test report**

Test results and test conditions shall be reported.

NOTE ISO/TR 11340 provides a method of reporting leakage.

**5 Repeated assembly test**

**5.1 Principle**

Unless otherwise specified in the respective connector standard, three type 1 test assemblies shall be tested to confirm that they are capable of meeting the necessary requirements after being disassembled and re-assembled several times.

**5.2 Procedure**

The tube connections of the straight stud connector (part A in [Figure 1](#)) and shaped connector (part C in [Figure 1](#)) shall be disassembled and re-assembled six times. Prior to each re-assembly, the tube shall be turned clockwise by 60°. On re-assembly, the nuts shall be tightened firmly, using the maximum torque values or number of turns given in the respective connector standard or by the manufacturer. All assemblies, after the first and sixth re-assembly, shall be subjected to a leakage test ([Clause 6](#)) and a proof test ([Clause 7](#)) at the test parameters specified in [Table 2](#).

**Table 2 — Parameters and procedure for repeated assembly test**

Test parameter	Value of parameter and procedure
Test medium	As specified in <a href="#">Clauses 6</a> and <a href="#">7</a> .
Test pressure	
Test duration	
Pass/fail criterion	Any leakage during the leakage and proof tests shall be considered a failure.

**5.3 Re-use of components**

Parts that pass this test may be used for burst and cycle endurance tests at the minimum specified assembly torque or number of turns. They shall not be used for actual service or returned to stock.

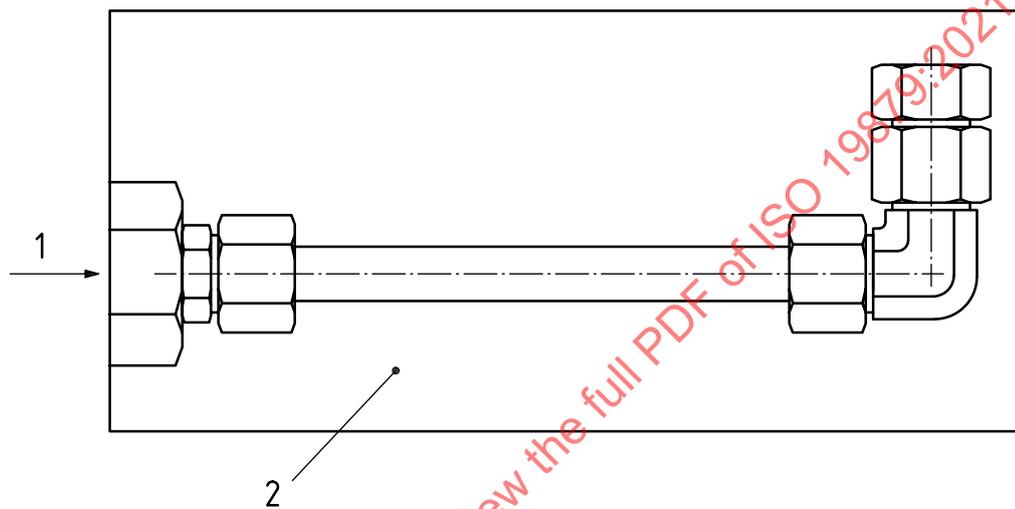
## 6 Leakage test

### 6.1 Principle

Unless otherwise specified in the respective connector standard, all type 1 test assemblies from the repeated assembly test and, where applicable, three type 2, type 3 or type 4 assemblies shall be subjected to a leakage test to ensure that assemblies do not leak when subjected to test pressure.

### 6.2 Procedure

Test assemblies shall be pressurized under water as shown in [Figure 5](#) and described in [Table 3](#).



#### Key

- 1 test fluid inlet
- 2 water

**Figure 5** — Typical test set-up for leakage test

**Table 3** — Parameters and procedure for leakage test

Test parameter	Value of parameter and procedure
Test medium	Air, nitrogen or helium. The test medium shall be recorded in the test report.
Test pressure	The test pressure shall be increased continuously until the pressure reaches a level equal to 15 % of the maximum working pressure of the connector, in accordance with the respective standard, where applicable, not exceeding 6,3 MPa (63 bar <sup>a</sup> ).
Test duration	A minimum of 180 sec. at the test pressure, after all of the air trapped in the connector's threads during test set-up has escaped.
Pass/fail criterion	Leakage, in the form of ascending bubbles, shall not occur in any of the test assemblies.
<sup>a</sup> 1 bar = 0,1 MPa = 10 <sup>5</sup> Pa; 1 MPa = 1 N/mm <sup>2</sup> .	

### 6.3 Re-use of components

Parts that pass this test may be used for further tests. They shall not be used for actual service or returned to stock.

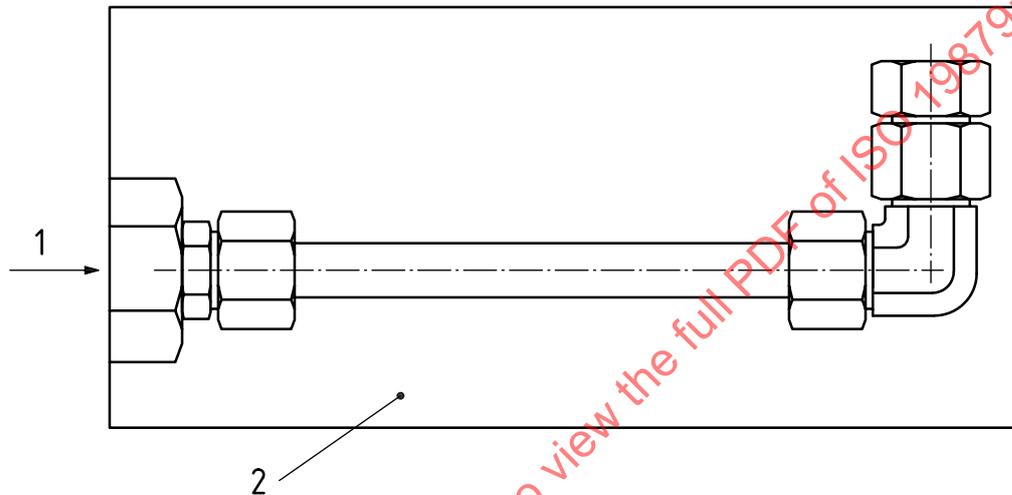
## 7 Proof test

### 7.1 Principle

Unless otherwise specified in the respective connector standard, three type 1 test assemblies and, where applicable, three type 2, type 3 and type 4 test assemblies shall be tested to confirm that the specified connections are capable of withstanding a minimum of two times the maximum working pressure of the connector without any visual sign of leakage.

### 7.2 Procedure

The test assemblies shall be pressurized as shown in [Figure 6](#) at the test parameters specified in [Table 4](#). Air shall be carefully bled from the test assemblies before applying static pressure.



**Key**

- 1 test fluid inlet
- 2 air

**Figure 6 — Typical test set-up for static proof pressure and burst test**

**Table 4 — Parameters and procedure for proof test**

Test parameter	Value of parameter and procedure
Test medium	Hydraulic fluid in accordance with ISO 6743-4 (e.g. HM) with a viscosity equal to or less than ISO VG 32, in accordance with ISO 3448, or water. The test medium shall be recorded in the test report.
Test pressure	Two times the maximum working pressure of the connector, in accordance with the respective standard, where applicable. Pressure shall be increased at a rate not exceeding 16 % of the maximum working pressure of the connector, per second, until the test pressure is reached.
Test duration	The test assemblies shall be held at the test pressure for a minimum of 60 sec.
Pass/fail criterion	None of the test assemblies shall leak during the test.

### 7.3 Re-use of components

Parts that pass this test may be used for the burst test. They shall not be used for actual service or returned to stock.

## 8 Burst test

### 8.1 Principle

Unless otherwise specified in the respective connector standard, three type 1 or type 3 assemblies and, where applicable, three type 2 and type 4 assemblies shall be tested to confirm that the specified connections are capable of withstanding a minimum of 4 times the maximum working pressure of the connector before failure.

### 8.2 Procedure

The test assemblies shall be pressurized as shown in [Figure 6](#) and described in [Table 5](#).

**Table 5 — Parameters and procedure for burst test**

Test parameter	Value of parameter and procedure
Test medium	Hydraulic fluid in accordance with ISO 6743-4 (e.g. HM) with a viscosity equal to or less than ISO VG 32, in accordance with ISO 3448, or water. The test medium shall be recorded in the test report.
Test pressure	Minimum test pressure shall be four times the maximum working pressure of the connector, in accordance with the respective standard, where applicable. Pressure shall be increased at a rate not exceeding 16 % of the maximum working pressure of the connector, per second.
Test duration	The test shall be continued until failure, whenever possible
Pass/fail criterion	None of the test assemblies shall show visual evidence of leakage at or below the minimum test pressure.

### 8.3 Re-use of components

Parts that pass this test shall not be tested further, nor used for actual service or returned to stock.

## 9 Cyclic endurance test

### 9.1 Principle

Unless otherwise specified in the respective connector standard, three type 1 or six type 3 assemblies and, where applicable, six type 2 and type 4 test assemblies shall be tested to confirm that they pass a cyclic endurance test at 133 % of maximum working pressure of the connector for 1 000 000 cycles without leakage or component failure, unless otherwise specified in the respective connector standard. For flange assemblies of DN 51 and larger, and connectors for tube OD sizes 50 mm and larger, the testing of three test assemblies shall be sufficient if the design has been verified through calculation or finite element analysis.

### 9.2 Procedure

The cyclic endurance test shall be conducted in accordance with the requirements specified in [Table 6](#).

### 9.3 Re-use of components

Parts that pass this test shall not be tested further, nor used for actual service or returned to stock.

**Table 6 — Parameters and procedure for the cyclic endurance test**

Test parameter	Value of parameter and procedure
Test medium	Hydraulic fluid in accordance with ISO 6743-4 (e.g. HM) with a viscosity equal to or less than ISO VG 32, in accordance with ISO 3448, or water. The test medium shall be recorded in the test report.
Test pressure	Test pressure shall conform to the waveform specified in ISO 6605 with peak pressure of 133 % of maximum working pressure of the connector, and an impulse frequency up to 2,0 Hz.
Test duration	Minimum of 1 000 000 pressure-impulse cycles.
Pass/fail criterion	None of the test assemblies shall leak or fail during the test.

## 10 Vacuum test

### 10.1 Principle

Unless otherwise specified in the respective connector standard, two type 1 test assemblies and, where applicable, two type 2 and type 4 test assemblies shall be tested to confirm that they are capable of withstanding a vacuum of 6,5 kPa (0,065 bar) absolute pressure for a minimum of 5 min without leakage.

### 10.2 Procedure

The vacuum test shall be conducted in accordance with the requirements of [Table 7](#).

**Table 7 — Parameters and procedure for vacuum test**

Test parameter	Value of parameter and procedure
Test medium	Air.
Test pressure	A vacuum of 6,5 kPa (0,065 bar) absolute pressure.
Test procedure	Connect test assembly to a vacuum source with a manometer and a shut-off valve that is close to the vacuum source. Draw a vacuum to the specified test pressure and close the shut-off valve. Hold the assembly at this pressure for the specified test duration. Leakage will be indicated by an increase in the absolute pressure reading.
Test duration	A minimum of 5 min.
Pass/fail criterion	The increase in the absolute pressure reading on any test assembly shall not exceed 3 kPa (0,03 bar).

### 10.3 Re-use of components

Parts that pass this test may be used for other tests or for actual service.

## 11 Overtightening test

### 11.1 Principle

Unless otherwise specified in the respective connector standard, six samples shall be tested, including three samples of a connector having a tube nut ([Figure 1](#) – component 2) and three samples of a connector having a swivel nut ([Figure 1](#) – component 1), to confirm that tube and swivel nuts are capable of withstanding the overtightening qualification test when tested to the overtightening (overtorque) values or over-tightening number of turns given in the respective connector standard.

## 11.2 Test equipment

Unless otherwise specified, an unplated threaded connector steel mandrel or body block including a tube connecting end with a minimum hardness of 35 HRC in accordance with ISO 6508-1 shall be used.

## 11.3 Procedure

Connectors shall be restrained during the test, and the wrench shall be located at the threaded end of the nut hex. The overtightening test shall be conducted in accordance with the requirements specified in [Table 8](#).

**Table 8 — Parameters and procedure for overtightening test**

Test parameter	Value of parameter and procedure
Test duration	Continue to apply torque to the nuts until the specified torque has been achieved. Unless otherwise specified, the overtightening torque shall be at least 1,5 times the test torque specified in the respective standard.
Pass/fail criterion	Parts are considered failing the test, if: <ul style="list-style-type: none"> <li>— the nut cannot be removed by hand after breakaway;</li> <li>— the nut cannot swivel freely by hand;</li> <li>— the nut will not retract to its original position by hand;</li> <li>— appearance of any visible cracks in the sealing surface or nut that would render the nut unusable.</li> </ul>

## 11.4 Re-use of components

Parts that pass this test shall not be tested further, used for actual service or returned to stock.

## 12 Vibration test

### 12.1 Principle

Unless otherwise specified in the respective connector standard, six test assemblies as shown in [12.2](#) shall be tested to confirm that the connector is able to withstand the specified vibration without leakage or component failure. For flange assemblies of DN 51 and larger and connectors for tube OD sizes 50 mm and larger, the testing of three test assemblies shall be sufficient if the design has been verified through finite element analysis.

### 12.2 Procedure

**12.2.1** Conduct the vibration test in accordance with the requirements of [Table 9](#) and as described in [12.2.2](#) to [12.2.7](#).

**Table 9 — Parameters and procedures for the vibration test**

Test parameter	Value of parameter and procedure
Test medium	Hydraulic fluid in accordance with ISO 6743-4 (e.g. HM), with a viscosity equal to or less than ISO VG 32, in accordance with ISO 3448, or water. The test medium shall be recorded in the test report.
Test pressure	Working pressure of the selected tube and lower than the maximum working pressure of the connector.
Bending-test stress level	25 % of the minimum yield strength of the tube but not exceeding 60 N/mm <sup>2</sup> .

**Table 9** (continued)

Test parameter	Value of parameter and procedure
Test vibration frequency	Fixed frequency in the range between 10-50 Hz.
Test duration	Minimum of 10 000 000 ( $10^7$ ) vibration cycles.
Pass/fail criterion	Any leakage or failure of any component prior to 10 000 000 cycles shall be considered a failure.

**12.2.2** Prepare the test assembly as shown in [Figure 7](#). The strain gauge shall be installed at the location specified in [Figure 7](#). The minimum gauge length,  $L$ , shall be in accordance with [Table 10](#).

**12.2.3** Install the test assembly in a test fixture that provides either rotary or axial (planar) vibration, as shown in [Figure 7](#).

**12.2.4** Pressurize the test assembly to the test pressure defined in [Table 9](#).

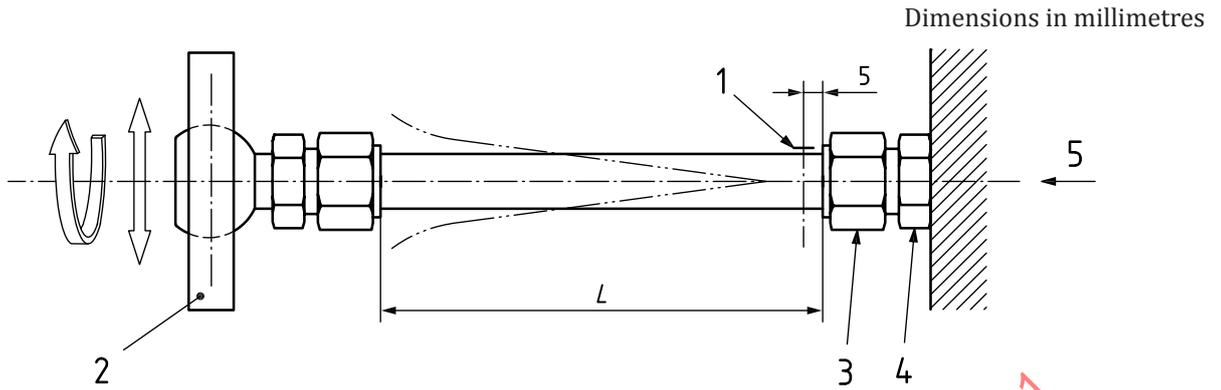
**12.2.5** Apply a bending load to the end of the tube opposite to the strain gauge until the combined axial stress is 25 % of the minimum yield strength of the tube.

NOTE When using tubes with minimum yield strength greater than 235 MPa consider the dynamic capability of the tube when determining the stress level used in the test.

**Table 10 — Minimum gauge lengths for vibration tests**

Dimensions in millimetres

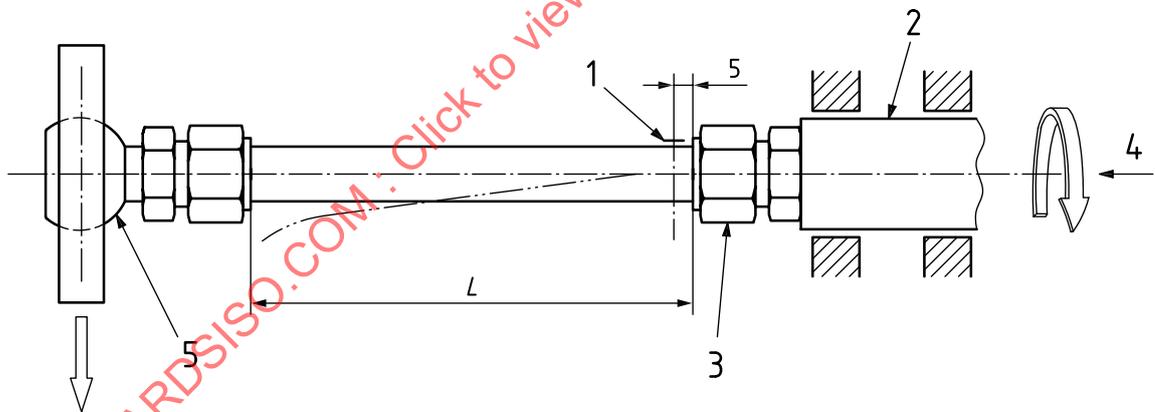
Tube outside diameter, $X$	Minimum gauge length, $L$
$X \leq 20$	250
$20 < X \leq 50$	250 or $8X$ , whichever is greater
$X > 50$	400 or $8X$ , whichever is greater



**Key**

- 1 strain gauge
- 2 driven end
- 3 test assembly
- 4 fixed end
- 5 hydraulic fluid or water supply

**a) Rotary or planar vibration test assembly and setup**



**Key**

- 1 strain gauge
- 2 driven end
- 3 test assembly
- 4 hydraulic fluid or water supply
- 5 location of load application

**b) Optional rotary vibration test assembly and setup**

**Figure 7 — Typical vibration test assemblies and setups**

12.2.6 Submit the test assembly to vibration of 10 Hz to 50 Hz until failure or 10 000 000 cycles, whichever occurs first.

12.2.7 If failure occurs before the test sample reaches 10 000 000 cycles, record the number of cycles reached and type of failure.

### 12.3 Re-use of components

Parts that pass this test shall not be tested further, nor used for actual service or returned to stock.

## 13 Cyclic endurance (impulse) test with vibration

### 13.1 Principle

Unless otherwise specified in the respective connector standard, three assemblies in accordance with [Figure 8](#) shall be tested to confirm that they pass, without leakage or component failure, a cyclic endurance test at 133 % of working pressure for 500 000 cycles, while simultaneously being subjected to vibration. For flange assemblies of DN 51 and larger and connectors for tube OD sizes 50 mm and larger, the testing of three test assemblies shall be sufficient if the design has been verified through calculation or finite element analysis.

### 13.2 Procedure

13.2.1 Conduct the cyclic endurance (impulse) test with vibration in accordance with the requirements of [Table 11](#) and [Figure 8](#).

**Table 11 — Parameters and procedures for the cyclic endurance (impulse) test with vibration**

Test parameter	Value of parameter and procedure
Test medium	Hydraulic fluid in accordance with ISO 6743-4, e.g. HM, with a viscosity equal to or less than ISO VG 32, in accordance with ISO 3448, or water. The test medium shall be recorded in the test report.
Test pressure	Test pressure shall conform to the waveform specified in ISO 6605 with peak pressure of 133 % of maximum working pressure of the connector, with an impulse frequency up to 2.0 Hz.
Bending-test stress level	25 % of the minimum yield strength of the tube but not exceeding 60 N/mm <sup>2</sup> .
Test vibration frequency	× 20 the impulse frequency.
Test duration	Minimum of 500 000 pressure-impulse cycles.
Pass/fail criterion	None of the test assemblies shall leak or fail during the test.

13.2.2 Prepare the test assembly as shown in [Figure 8](#). The strain gauge shall be installed at the location specified in [Figure 8](#). The minimum gauge length, *L*, shall be in accordance with [Table 10](#).