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Third edition
2025-01

Refrigerating systems and heat pumps — Qualification of tightness of components and joints

Systèmes de réfrigération et pompes à chaleur — Qualification de l'étanchéité des composants et des joints

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Foreword

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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 document 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).

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This document was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 182, *Refrigerating systems, safety and environmental requirements*, in collaboration with ISO Technical Committee TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 1, *Safety and environmental requirements for refrigerating systems*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 14903:2017), which has been technically revised.

The main changes are as follows:

— update of the test procedure:
  — PTV test:
    — deletion of previous method 1 "Combined pressure-temperature cycle test with integrated vibration test";
    — update of previous method 2 "Combined pressure-temperature cycle test with a separate vibration test".
  — pressure test: modification of the test pressure specification;
— modification of Figure 2 "Test procedure": the compatibility test is moved out of the tightness test;
— deletion of previous Annex B "Test arrangements".

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.

Introduction

This document is intended to characterize the tightness stresses of joints of maximum DN 50 and components of internal volume of maximum 5 l and maximum weight of 50 kg met during their operations, following the fitting procedure specified by the manufacturer. This document is also intended to specify the minimal list of necessary information to be provided by the supplier of a component to the person in charge of carrying out this procedure.

Refrigerating systems and heat pumps — Qualification of tightness of components and joints

1 Scope

This document specifies the qualification procedure for type approval of the tightness of hermetically sealed and closed components, joints and parts used in refrigerating systems and heat pumps as described in relevant parts of the ISO 5149 series, including metal flexible piping. It specifies the level of tightness of the component as a whole and its assembly as specified by the manufacturer. It specifies additional requirements for mechanical joints that can be recognized as hermetically sealed joints.

This document is applicable to joints of maximum DN 50 and components of internal volume of maximum 5 l and maximum weight of 50 kg.

It is applicable to the hermetically sealed and closed components, joints and parts (e.g. fittings, bursting discs, flanged or fitted assemblies) used in the refrigerating installations, including those with seals, whatever their material and design are.

This document does not apply to the tightness of flexible piping made from non-metallic material. This is covered in ISO 13971.

Components tested before the date of publication of this document and found to comply with ISO 14903:2017 are considered to comply with this document.

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 175, *Plastics — Methods of test for the determination of the effects of immersion in liquid chemicals*

ISO 1817, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

ISO 5149-1, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 1: Definitions, classification and selection criteria*

ISO 20485:2017, *Non-destructive testing — Leak testing — Tracer gas method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5149-1 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
mass flow rate
Q_m
value of the leak mass flow rate at any point of the component

Note 1 to entry: The mass flow rate is expressed in grams per year (g/a).

3.2
volume flow rate
Q
value of the leak volume flow rate at any point of the component

Note 1 to entry: The volume flow rate is expressed in Pascal cubic metres per second ($Pa \cdot m^3/s$).

3.3
product family
group of products that have the same function, technology and material for each functional part and sealing materials

3.4
closed joint
joint other than hermetically sealed joints where there is no movement between the sealing surfaces except for service purposes

EXAMPLE Flanged joints.

3.5
closed component
component other than hermetically sealed components where there is no movement between the sealing surfaces except for service purpose

EXAMPLE Stop valves, service ports, pressure-relief valves.

3.6
hermetically sealed joint
joint that is made tight by welding, brazing or a similar permanent connection

3.7
hermetically sealed component
component that is made tight by welding, brazing or a similar permanent connection

3.8
permanent joint
joint which cannot be disconnected except by destructive methods

[SOURCE: Pressure Equipment Directive 2014/68/EU]

3.9
reusable joint
joint made without replacing the sealing material in general procedure

Note 1 to entry: In some cases, the tube is used as sealing material (e.g. flared joint).

3.10
same base material
material belonging to the same group

EXAMPLE Steel group, aluminium and aluminium alloy group, or copper group.

Note 1 to entry: Subgroups of these material groups are considered to be same base materials (refer to EN 14276-1 and EN 14276-2).

4 Symbols

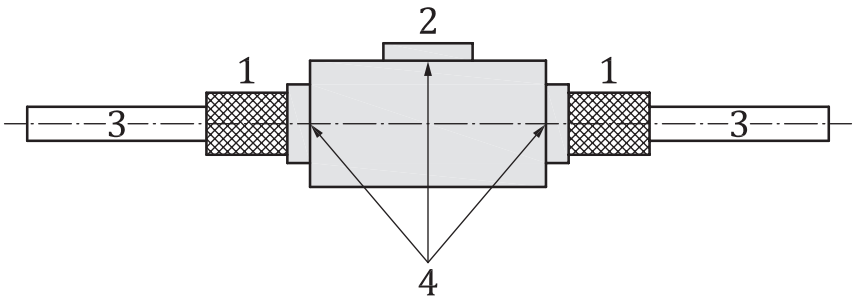
Symbol	Denomination	Unit
D_K	percentage deviation of the minimum and maximum torque from the average of the minimum and maximum torque, $(K_{max} - K_{min})/(K_{min} + K_{max})$	—
f	frequency of vibrations	Hz
K_{ave}	average torques of the respective joint standard, if specified. Otherwise, average of K_{min} and K_{max}	Nm
K_{test_max}	maximum torque used for testing a joint	Nm
K_{test_min}	minimum torque used for testing a joint	Nm
K_{max}	required maximum torques of the respective joint standard if specified; otherwise, the maximum torque values supplied by the manufacturer	Nm
K_{min}	required minimum torques of the respective joint standard if specified; otherwise, the minimum torque values supplied by the manufacturer	Nm
L	length of tube	mm
n_1	number of cycles in temperature and in pressure	—
n_2	number of cycles in pressure	—
n_3	number of cycles in vibration	—
n_{total}	total number of cycles in temperature and in pressure	—
N	number of samples	—
P	tightness test pressure	bar
P_{max}	maximal pressure of cycle	bar
P_{min}	minimal pressure of cycle	bar
PS	maximal allowable pressure	bar
P_{set}	nominal set pressure of the device	bar
Q	volume flow rate	$Pa \cdot m^3/s$
Q_m	mass flow rate	g/a
s	vibration displacement (peak to peak value)	mm
T_{max}	maximal temperature of cycle	°C
T_{min}	minimal temperature of cycle	°C

5 Test requirements

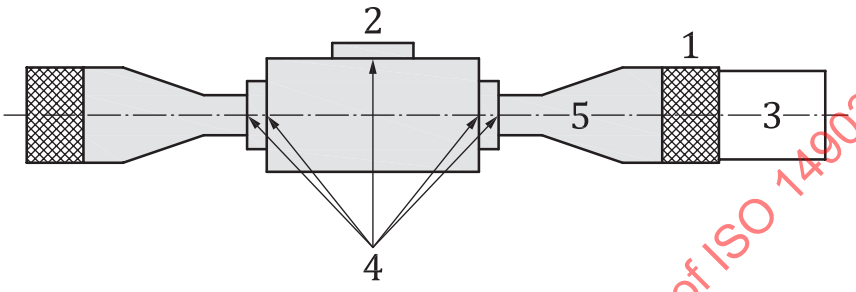
The tests that shall be applied to component bodies and joints used in refrigerating systems and heat pumps are given in Table 1 and in Table 2.

When a component can be connected with different types of joints, one of these joints shall be tested with the component according to Table 1. The other possible types of joints shall be tested independently according to Table 2.

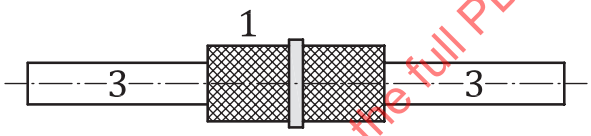
Figure 1 illustrates the principle of a component and a joint.



a) According to Table 1



b) According to Table 1



c) According to Table 2

Key

1	joint	4	component body joint
2	component body	5	extension pipe
3	pipe		

Figure 1 — Principle of component body joint and joining of components

Table 1 — Requirements for component bodies

Components (including valves)	**Requirements**							
	Tightness test	**PTV test** (pressure-temperature-vibration)	**Operation simulation**	**Freezing test**	**Chemical compatibility with materials**	**Vacuum test**	**Additional test for hermetically sealed components**	
							Pressure test	**Fatigue test**
Subclause	7.4	7.6	7.7	7.8	7.11	7.10	7.9	7.12
Component bodies having only permanent joints: brazing and welding Same base materials	YES	NO	NO	NO	NO	NO	NO	NO
Components having permanent joints: brazing and welding Not same base materials	YES	YES [a]	NO	NO	NO	NO	NO	NO
Component bodies having other permanent joints (e.g. glue, permanent compression fittings, expansion joints)	YES	YES	NO	YES if operating temperature below 0 °C	YES if non-metallic parts	YES	YES	YES
Component bodies with non-permanent joints	YES	YES	YES if any external stems, shaft seals or removable or replaceable parts	YES if operating temperature below 0 °C	YES if non-metallic parts	YES	Not applicable	Not applicable
Capped valves and capped service ports for sealed systems	YES	YES	YES	YES if operating temperature below 0 °C	YES if non-metallic parts	YES	YES	YES
Safety valves	YES	YES	NO	NO	YES if non-metallic parts	Not applicable	Not applicable	Not applicable
Flexible piping	Test according to ISO 13971							

By exception, compressors that conform to the requirements of EN 12693 or IEC 60335-2-34 only need to be subjected to the following test:

— joints connecting to other parts of the refrigerating systems;

— chemical compatibility test for all gaskets (sight glass, etc.).

[a] PTV tests are not required if destructive and non-destructive tests of EN 13134 are carried out.

NOTE Other qualifications for this chemical compatibility done according to other standards are equivalent.

Table 2 — Requirements for the joining of components

Joints and parts	Requirements							
	Tightness test	**PTV test** (pressure-temperature-vibration)	**Operation simulation**	**Freezing test**	**Chemical compatibility with materials**	**Vacuum test**	**Additional test for hermetically sealed joints**	
							Pressure test	**Fatigue test**
Subclause	7.4	7.6	7.7	7.8	7.11	7.10	7.9	7.12
Permanent joints for piping: brazing and welding Same base materials	YES	NO	NO	NO	NO	NO	NO	NO
Permanent joints for piping: brazing and welding Not same base materials	YES	YES	NO	NO	NO	NO	NO	NO
Other permanent joints for piping (e.g. glue, permanent compression fittings, expansion joints)	YES	YES	NO	YES	YES	YES	YES	YES
Non-permanent joints for piping	YES	YES	YES	YES	YES, if sealing material	YES	Not applicable	Not applicable
Gaskets and sealing	NO	NO	NO	NO	YES	NO	Not applicable	Not applicable

6 Requirements for sealed systems

Sealed systems shall be constructed with components that have their tightness control level qualified as A1 or A2 as per Table 3 or Table 4. These components and joints shall be subjected to the relevant tests as specified in Table 1 and Table 2.

7 Test procedures

7.1 General

The components, joints and part shall pass the tightness test before the other tests are executed. The different tests are shown in Figure 2.

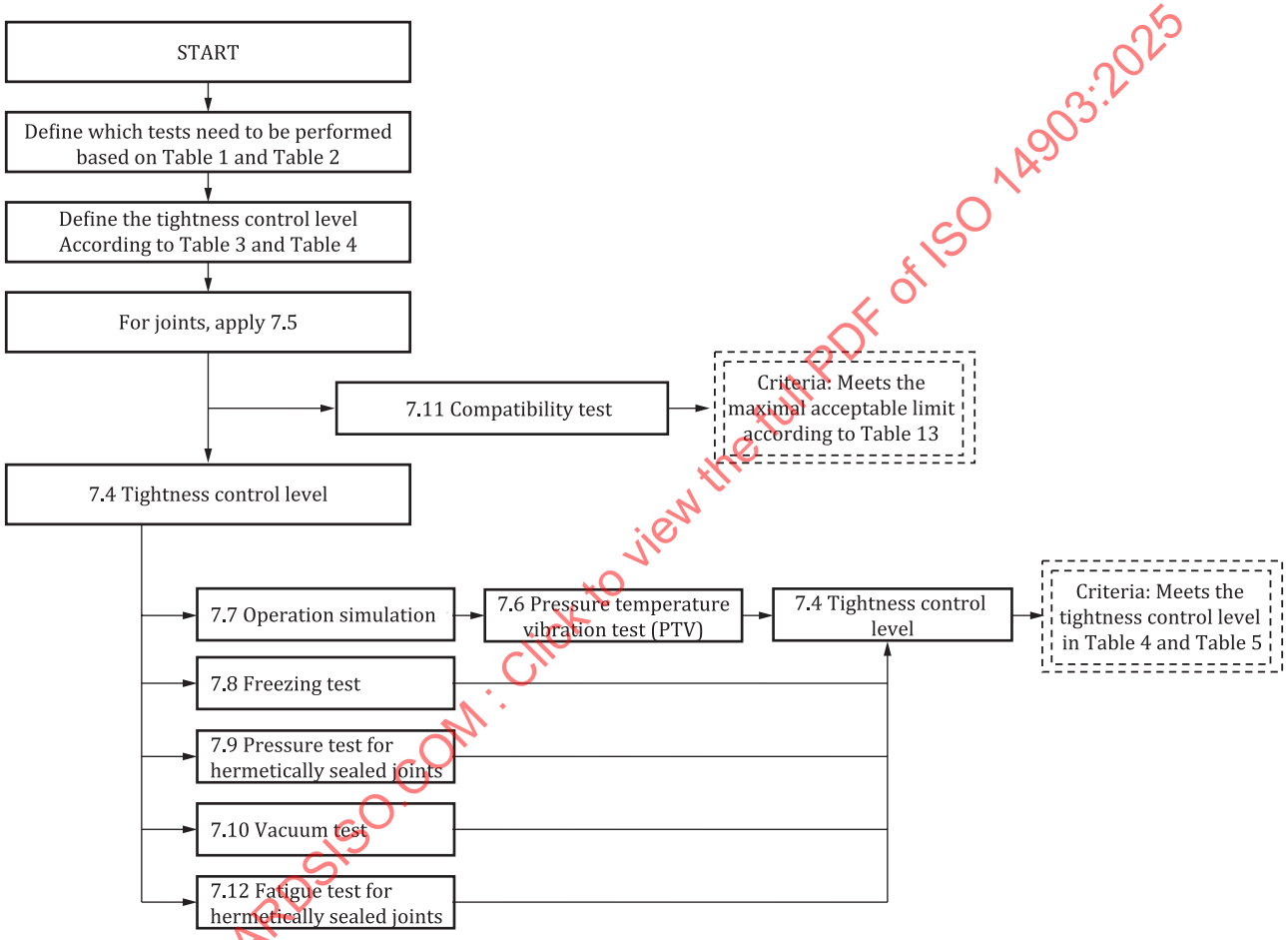


Figure 2 — Test procedure

7.2 Sampling

The largest, the smallest and any random samples in between of the product family shall be subjected to the test as required in Table 1 or Table 2. The samples used for the pressure-temperature vibration test (7.6) and for the operation simulation (7.7) shall be the same. For each of the other tests (7.8, 7.9, 7.10, 7.11, 7.12), different samples may be used.

7.3 Test temperature

Test temperature (ambient and gas) shall be 15 °C to 35 °C, unless otherwise specified as the test conditions.

7.4 Tightness test

7.4.1 General

The tightness of components and joints shall be tested according to the following test pressures.

For pressure relief devices: P = 0,88 × P_{set} to 0,9 × P_{set}

For all other components and joints: P = 1,00 × PS to 1,02 × PS

Q ≤ requirements for actual tightness control level A1 – A2 (hermetically sealed components) or B1 – B2 for all other components

The maximum required tightness control level is specified for helium at 10 bar and +20 °C as a reference.

The actual tightness control levels can be calculated (e.g. for other test fluids or pressures) by using the stated calculation formulae (Annex A).

The maximum tightness control level depends on the size of the tested component or joint. Tightness control levels are specified in accordance with the joints used in Table 3.

Table 3 — Tightness control level according to joints nominal diameter

Joints	DN	Tightness control levels
Hermetically sealed joints	≤ 50	A1
Closed joints	≤ 50	B1

For components, the tightness control level depends on the component internal volume and the type of component as specified in Table 4.

Table 4 — Tightness control level according to components volume

Components	Component volume l	Tightness control levels
Hermetically sealed components	0 up to 1,0	A1
	> 1,0	A2
Closed components	0 up to 2,0	B1
Closed components	> 2,0 up to 5,0	B2

The manufacturer can choose more stringent tightness control level if adequate.

The tightness criteria are given in Table 5.

Table 5 — Equivalence of test gas flow according to tightness control levels

Component type	Tightness control level at +20 °C, 10 bar	Helium reference leak Q Pa·m³/s	Equivalent air leak Q Pa·m³/s	Equivalent iso-butane leak Q_m g/a
Hermetically sealed	A1	≤ 7,5 × 10^{-7}	≤ 8 × 10^{-7}	≤ 1,5
	A2	≤ 1 × 10^{-6}	≤ 11 × 10^{-7}	≤ 2,0
Closed	B1	≤ 1 × 10^{-6}	≤ 11 × 10^{-7}	≤ 2,0
	B2	≤ 2 × 10^{-6}	≤ 2,1 × 10^{-6}	≤ 4,0
NOTE The equivalent iso-butane leak is calculated as gas. At +20 °C and 10 bar, iso-butane is in the liquid phase. See R-600a in Table A.1.				

7.4.2 Tightness level control

7.4.2.1 Test method

NOTE 1 EN 1779 gives guidance on the criteria for method and technique selection.

The tightness control level of joints and components shown in Table 3 and Table 4 shall be measured by the vacuum chamber technique which sum all leak.

It is preferable to use tracer gas technique as specified in ISO 20485:2017, 9.8.

The component to be tested is pressurized with the tracer gas and placed in the vacuum chamber in which the sum of all components leak is measured.

The following procedure shall be carried out to measure the tightness control level:

— connect the vacuum chamber to the detector;

— connect the component to the tracer gas pressure generator (in the vacuum chamber) (see Figure 3);

— close the vacuum chamber and start the leak detector (and if necessary add a vacuum pump);

— adjust and calibrate the leak detector according to ISO 20485:2017, 8.2.1;

— measure the residual signal in the vacuum chamber and the component without helium pressure;

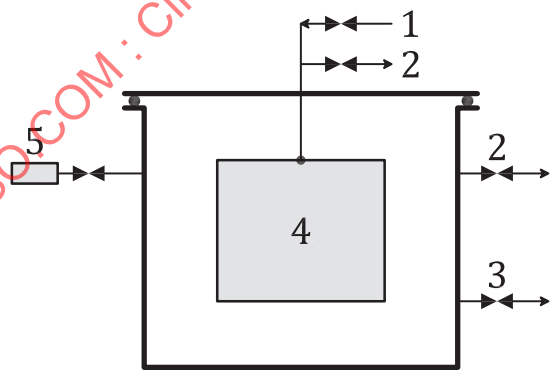
— adjust the test pressure in the component;

— measure the leak signal of the component;

NOTE 2 This signal is the total flow of the tracer gas from the component measured by the leak detector.

— calculate the leak level according to the formula given in ISO 20485:2017, 8.3.7.

If joints and/or components are tested together, the total level shall fulfil the most stringent tightness control level of the individual joint or component.



Key

1	tracer gas (*P*)	4	test object
2	vacuum	5	calibrated leak
3	mass spectrometric leak detector		

Figure 3 — Principle of tightness control — Tracer gas

7.4.2.2 Alternative test methods

Two alternative methods may be applied.

a) Alternative method 1

The control by pressure technique by accumulation according to ISO 20485:2017, 9.5.2, can be used to measure the leak rate of the component.

b) Alternative method 2

Bubble test methods shown in Figure 4 can be acceptable for tightness control level B, provided that the method is capable of measuring the actual leakage rate. The bubble test methods shall be carried out in accordance with EN 1593. The accuracy of the selected method shall be verified and conform to the requirements for actual tightness control level. If this method is used, the following requirements shall be applied:

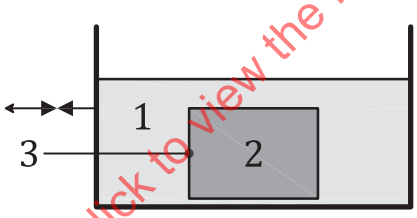
1) the test object shall be subjected to an internal air pressure = *PS* (maximum allowable pressure). Reduced pressure is not acceptable;

2) the test object shall be immersed in water;

3) the test object shall be exposed to atmospheric pressure;

4) the test shall be performed at normal ambient temperature;

5) the period of time between bubbles leaving the test object shall be more than 60 s.



Key

1 water
2 test object
3 air pressure (*PS*)

Figure 4 — Principle of tightness control — Bubble method

7.5 Requirements for joints

7.5.1 Test samples

All joints tested shall be tested in the final form as the customer receives the part.

All joints shall be subjected to the tests as indicated in Table 2.

7.5.2 Torque

Where relevant, tube joints shall be tested both at the minimum torque, K_{test_min}, and the maximum torque, K_{test_max}, specified in Table 6.

NOTE For a reusable joint with a thread connection, this implies that two sets of samples are used for the tests of Table 2, one set tested at K_{test_min} and one set tested at K_{test_max}.

Table 6 — Torque for the test, K_{test_min} and K_{test_max}

	K_{test_min}	K_{test_max}
If $D_K \geq 20$ %	K_{min}	K_{max}
If 20 % > D_K	0,8 × K_{ave}	1,2 × K_{ave}

7.5.3 Reusable joint

If the joints to be tested are reusable, the following steps shall be taken before the test:

a) fit the joints to tubes to be connected and tighten the joints to the maximum torque, K_{test_max}, specified in Table 6;

b) loosen the joints and take the tubes completely apart;

c) repeat a) and b) four more times.

NOTE This implies that before starting the tests of Table 2, all samples are assembled and disassembled five times, each time with the sealing material changed and applying K_{test_max} torque.

7.5.4 Requirements for hermetically sealed joints

The joint shall not be opened without the use of special tools.

NOTE Special tools are other than screw-drivers, parallel wrenches, simple gripping tool, etc.

The joint shall not be reusable without replacing the sealing material in normal use. In case the sealing material is the tube, including that the tube is deformed during the sealing process, the deformed part of the tube shall not be reusable for sealing purposes.

7.6 Pressure-temperature vibration tests (PTV)

7.6.1 General

In order to qualify the tightness level, joints and components shall be subjected to the pressure-temperature and vibration tests as specified below.

7.6.2 Samples

For the combined cycle test, the number of samples is determined based on tightness control level according to Table 7.

Table 7 — Test parameters

Tightness control level	Number of samples
A1, B1	3
A2, B2	2

7.6.3 Test equipment and arrangements

7.6.3.1 Equipment

Test equipment shall be composed of:

a) regulated enclosure for environment tests, able to maintain temperatures varying regularly between T_{min} and T_{max};

b) pressure device, connected to the joints, capable of producing a pressure that varies between P_{min} and P_{max};

c) vibration generator, to make the specified frequency and amplitude;

d) pressure control system capable of controlling the pressure with an accuracy of ±5 %;

e) temperature control system capable of controlling the temperature inside of the test enclosure with an accuracy of ±5 K;

f) temperature sensor capable of monitoring the temperature (T_{max}, T_{min}) of the component or joint subjected to the test.

The temperature sensor shall be adhered to the surface of the sample on the item with the biggest weight concentration of the pressure bearing part in order to ensure that the sample has reached the specified temperature values. Where the pressure bearing part is made from metallic and non-metallic materials, the sensor shall be fixed on the non-metallic material.

The sensor can be fixed to the sample by soldering or with adhesives, whichever is more appropriate, depending on the material of the sample.

Another method, proven to have the same performance as the thermocouple can be applied.

g) cycle counter of temperature and pressure;

h) test equipment to perform tightness test according to 7.4.

7.6.3.2 Test arrangements

The test samples shall be mounted as shown in Figure 7 in accordance with the number of joints to be tested and with the dimension of the climatic enclosure in which the tests are carried out.

The tube section shall have a diameter and dimensional tolerances such as specified by the manufacturer of the joint.

The assembly of the joints on the tube shall be carried out following the fitting instructions of the manufacturer.

For the pressure test, one end of a tube shall be connected to the pressure generator; the other end shall be tightly closed.

7.6.4 Method: Combined pressure-temperature cycle test with a separate vibration test

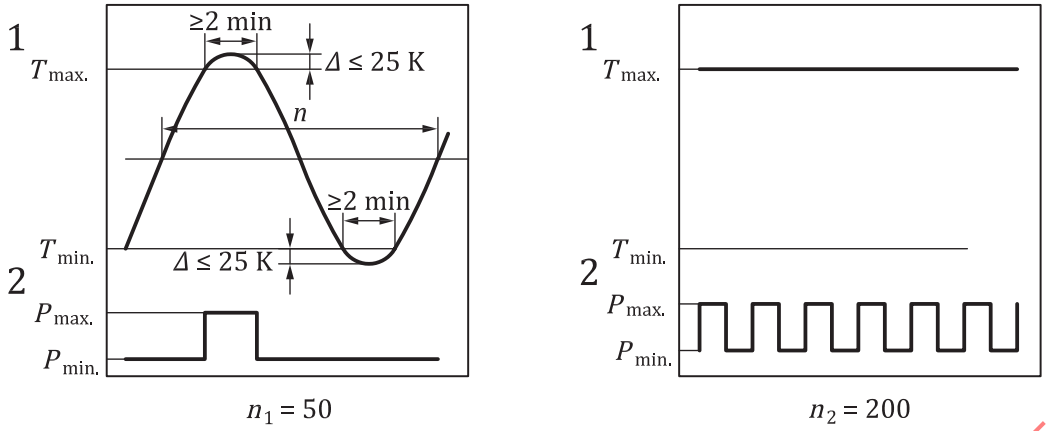
7.6.4.1 Requirements for the combined pressure-temperature cycle test

The samples shall be subjected to a specified number n_1 of cycles of temperature and pressure, between maximal values (T_{max}, P_{max}) and minimal values (T_{min}, P_{min}), and n_2 cycles of pressure between maximum value (P_{max}) and minimum value (P_{min}) with fixed temperature value (T_{max}).

The test characteristics to be applied to the components are given in Table 8.

A typical temperature-pressure cycle is given in Figure 5.

NOTE The shape of the curve is theoretical.



Key

1 temperature

2 pressure

Figure 5 — Temperature-pressure cycle test with a separate vibration test

Table 8 — Test parameters

Parameters	Value
n_1	50
n_2	200
T_{min}	minimum temperature as specified by the manufacturer or −40 °C if this is not specified
T_{max}	maximum temperature as specified by the manufacturer or +140 °C if this is not specified
P_{min}	atmospheric pressure
P_{max}	for safety valves, $P_{max} = 0{,}85 \times P_{set}$
	for other components 1,0 × *PS* [a]

[a] 1,0 × *PS* is proposed because of safety issue for test on big component. In the method, the number of cycles and the level of vibration are extended to compensate for the reduced pressure.

The test fluid shall not be a liquid.

7.6.4.2 Procedure

The following procedure shall be followed:

— Fit the test items on a test-bed in accordance with the instructions of the manufacturer.

— Fix the test parameters (n_1, n_2, T_{max}, T_{min}, P_{max}, P_{min}) in accordance with Table 8.

— Subject the test items to the test pressure according to Table 8.

— Check the tightness of the joints in order to detect leaks before test.

— Tighten again the joints that leak according to the instructions of the manufacturer.

— Execute the operation simulation according to 7.7.

— Place the joints in the climatic enclosure and subject them to n_1 and n_2 pressure and temperature cycles in accordance with Figure 5 and Table 8.

7.6.4.3 Vibration test

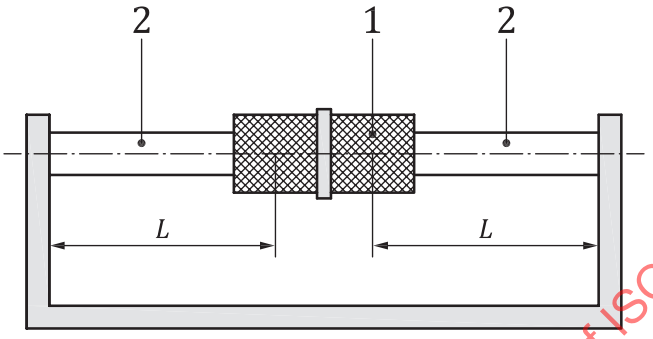
7.6.4.3.1 General

The component and joints shall be subjected to a vibration test.

Perform the sinusoidal and random vibration test on the same sample.

The frequency measurement shall be made on the component.

An example of vibration assembly for joint is given in Figure 6.

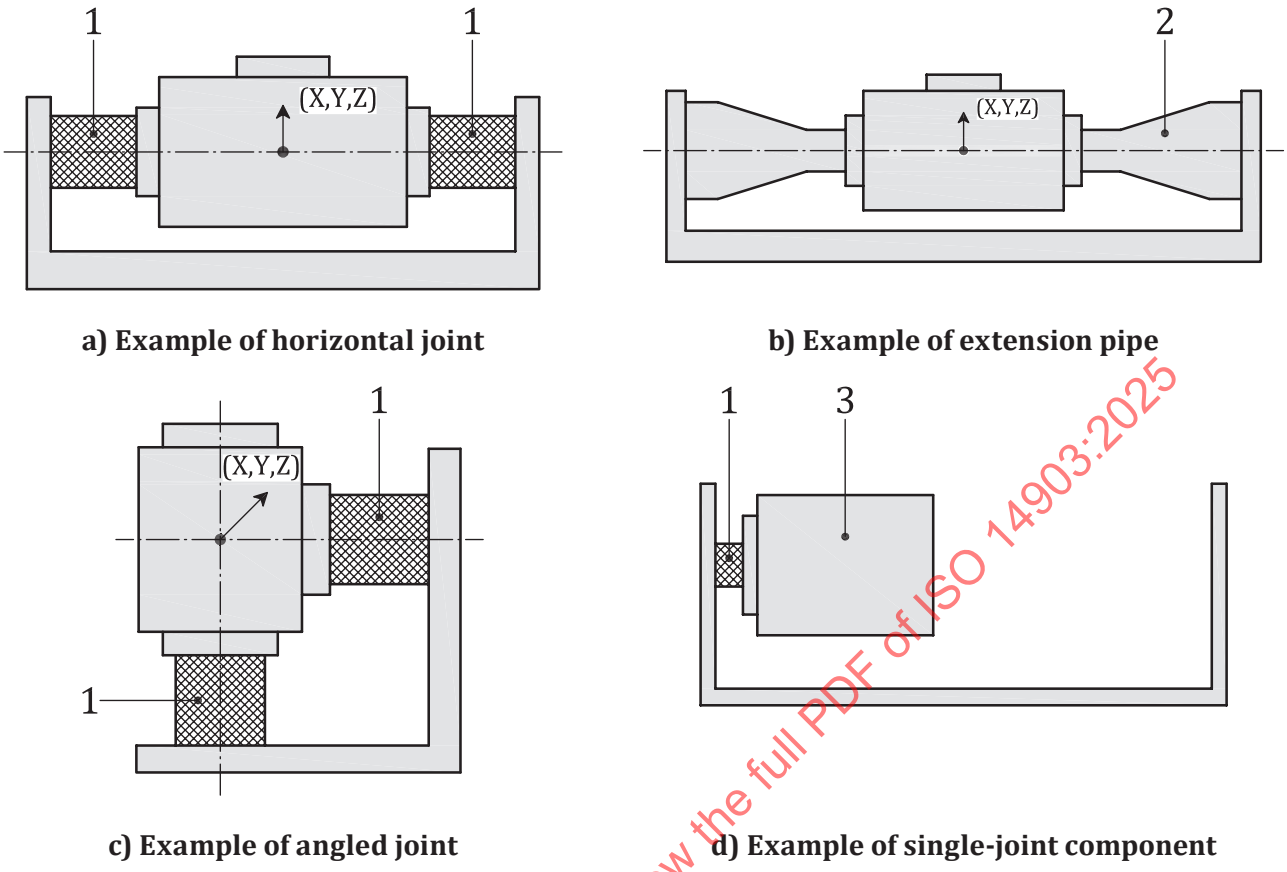


Key

1 joint
3 pipe
L length (200 mm, only for joints)

Figure 6 — Vibration assembly for joint

Examples of vibration assembly for component are given in Figure 7.



a) Example of horizontal joint

b) Example of extension pipe

c) Example of angled joint

d) Example of single-joint component

Key

1 joint
2 extension pipe
3 component body

Figure 7 — Vibration assembly for components

The samples are fixed according to the manufacturer's instructions. Otherwise, the main body of the sample should be fixed as close as possible to the joint.

7.6.4.3.2 Procedure

The following procedure shall be applied:

— Before testing, execute the operation simulation according to 7.7.

— Fit the test items on a test-bench in accordance with the instructions of the manufacturer.

— Fix the test parameters for components in accordance with Table 9 and Table 10 (see also Figure 8).

— Subject the samples to the vibration test according to the numbers of tests specified in the respective tables.

— At the end of the vibrations test, subject the samples to the tightness test specified in 7.4. The pass-fail criteria shall be the tightness control levels according to the test gas shown in Table 5.

7.6.4.3.3 Sinusoidal loading

NOTE Sinusoidal testing is based on IEC 60068-2-6 testing procedures.

The components shall meet the specifications given in Table 9.

Table 9 — Test parameters for sinusoidal vibration

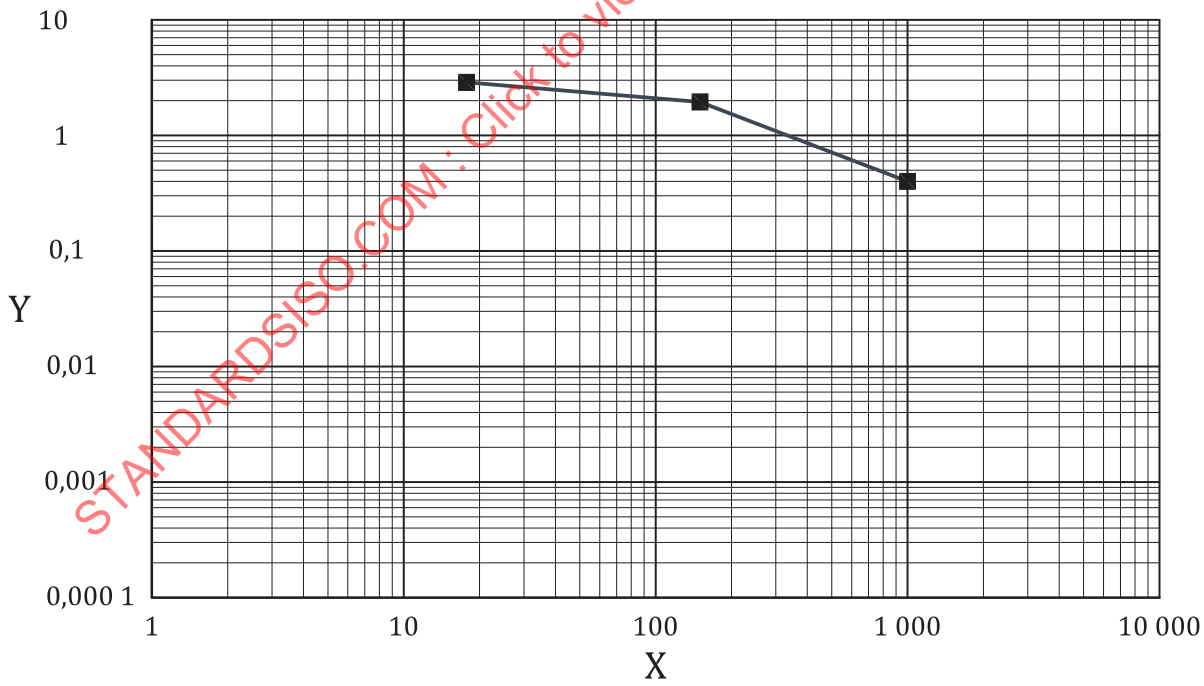
Parameters	Value
Frequency range	10 Hz to 200 Hz
Acceleration	0,7 g
Sweep speed	1 octave/min
Number of excitation directions [a]	3 (x-y-z)
Duration	2 h in each direction
[a] Numbers of excitation directions can be reduced to two on symmetric shaped components.	

7.6.4.3.4 Random loading

NOTE Random testing requirement covers installations near the source of vibration.

Table 10 — Test parameters for random testing

	Frequency Hz	Acceleration PSD [a] $(m/s^2)^2/Hz$	Acceleration PSD g^2/Hz
Value	20	2,88	0,03
	150	1,92	0,02
	1 000	0,38	0,004
Acceleration (RMS)	3,1 g		
Duration	2 h		
[a] The power spectral density is illustrated in Figure 8.			



Key

X frequency, in Hz

Y acceleration PSD, in $(m/s^2)^2/Hz$

Figure 8 — Power Spectral Density (PSD)

7.7 Operation simulation

The operation of maintenance and operating shall be carried out according to Table 11.

Table 11 — List of operations

Components	Operations	Maintenance and operating
Component body with non-permanent joints (e.g. valves)	Ten times before n_1, ten times before n_2 and five times before vibration test, total of 25 operations (open and close)	Disassembly/reassembly of the cap if any
Non-permanent joints for piping (e.g. fittings)	Ten times before n_1, ten times before n_2 and five times before vibration test, total of 25 operations (disassembly/reassembly)	Gasket change

At the end of this test, the value of Q_{max} shall be measured and shall not exceed the required value of 7.4.

7.8 Freezing test

This test shall be applied to joints specified for use below 0 °C.

The test shall be performed on three samples.

The joint shall be assembled according to the instructions of the manufacturer.

Both ends of the pipe shall be tightly hermetically sealed to prevent water from entering the pipes.

It should be ensured that the joint is tight by testing.

The test shall be carried out according to the following procedure (see Figure 9):

a) Put the sample into a vacuum test chamber.

   1) Fill the test chamber with water so all parts of the joint are submerged under water.

   2) Reduce the pressure in the test chamber to 40 kPa to 50 kPa absolute, and maintain for at least 10 min.

   3) Increase the pressure in the test chamber to atmospheric pressure, to fill gaps in the joint with water.

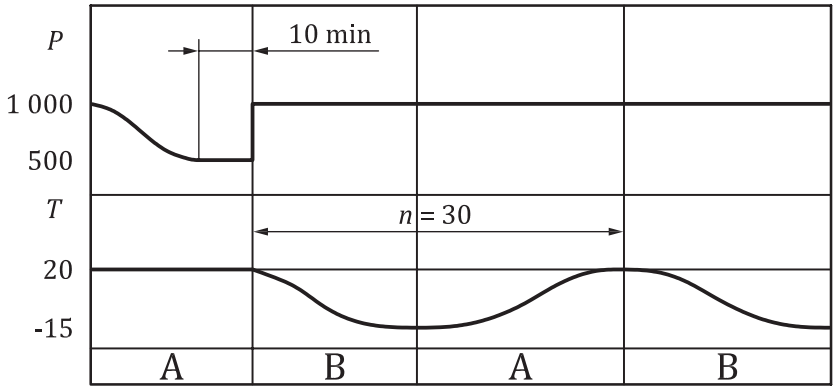
b) Remove the water from the test chamber.

c) Reduce the temperature until the temperature of the component has reached −15 °C or lower and maintain the temperature of the test chamber for at least 30 min. Samples shall be put in the most unfavourable direction so that the injected water is contained.

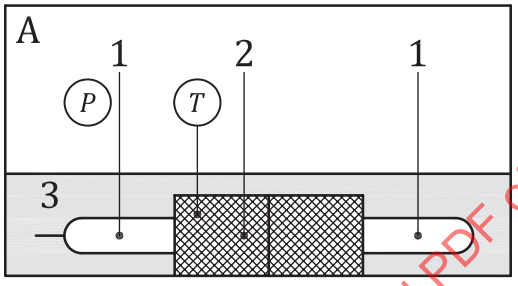
d) Immerse the sample into water at ambient temperature for at least 5 min so that the ice in gaps melts.

Repeat the process b), c) and d) 30 times.

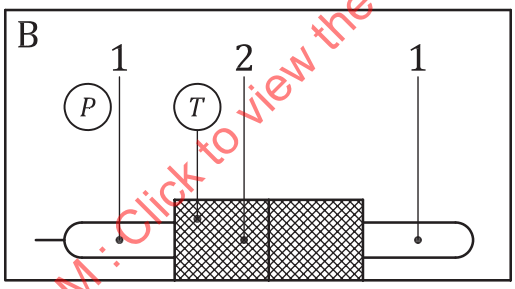
After this test, samples shall satisfy the test according to 7.4.



a) Pressure and temperature during the freezing test



b) Phase A – submerged in water



c) Phase B – freezing of sample

Key

1 pipe
2 joint
3 water
P pressure
T temperature

Figure 9 — Freezing test

7.9 Additional pressure test for hermetically sealed joints

Pressure shall be applied to at least three assembled joints with tubes. Tubes shall have a thickness according to appropriate standard withstanding at least three times *PS*. Pressure shall be increased until it reaches three times *PS*. Pressure shall be increased gradually where the increase may be faster at the beginning and shall be reduced in the relevant pressure range accordingly, so that the target-pressure can be reached clearly. Assembly shall withstand at least three times *PS* for 1 min.

For the test on joints where it is not feasible to use a stronger tube since the tube is an essential part of the joint, the test pressure should be the strength-pressure of the tube.

The fluid used for this test shall be liquid such as oil, water, etc. The liquid shall be totally removed before the tightness test.

7.10 Vacuum test

Test two samples to confirm that they are capable of withstanding an absolute pressure of not more than 6,5 kPa for 1 h without leakage. Leakage shall be checked by monitoring the pressure and confirming that the pressure rise after 1 h be less than 0,2 kPa. The effect of temperature change on joint shall be taken into account.

NOTE Temperature changes can change the pressure.

7.11 Compatibility screening test

7.11.1 General

When joints use sealing material, either solid or liquid, compatibility of the sealing material with the refrigerant, the lubricant, etc. to be used shall be checked. Where the manufacturer can document a method showing that the material is suitable for the application, that method can be accepted. This compatibility screening test specifies the method of evaluating the resistance of rubber and thermoplastic seals to the action of refrigerant and lubricants by measuring the properties of the seals before and after exposure to selected refrigerant-lubricant systems.

7.11.2 Test fluids

Sealing materials for multipurpose components shall be tested with fluids recommended by the manufacturer (refrigerants and oils). The material compatibility with refrigerants blends/oil mixtures shall be evaluated on the basis of the single components or specified blends.

Using sealing designs intended for operating with oil, oil shall be added to the test fluid (5 wt. % oil).

For refrigerants, the content of the different refrigerant components shall fulfil the requirement given in Table 12.

Table 12 — Composition of test fluid

Actual fluid	Test fluid
C [a] ≤ 5	C- actual −0 / +10
5 < C ≤ 10	C- actual −0 / +15
10 < C ≤ 20	C- actual −5 / +20
20 < C ≤ 40	C- actual −10 / +25
40 < C ≤ 60	C- actual −15 / +30
60 < C ≤ 100	C- actual −20 / +40
[a] C is the actual composition weight %.	

7.11.3 Test specimens

The following test conditions shall be fulfilled:

— a minimum of five test pieces shall be used for testing;

— the general requirements for test items shall conform to ISO 1817 for rubber seal materials and ISO 175 for thermoplastic seal materials.

7.11.4 Test setup parameters

The following conditions shall be fulfilled:

— the exposure shall be carried out in a test chamber (autoclave) suitable for safely handling refrigerants under high pressure;

— the test chamber shall be filled to a maximum of 75 % of its volume with the refrigerant-lubricant fluid mixture, allowing expansion of the fluid under the elevated test temperature;

— the exposure shall be carried out at a temperature of 50 °C, either by placing the test chamber in an oven or by direct heating of the test chamber.

If the critical temperature of the refrigerant is below 45 °C, the test temperature shall be 5 K below the critical temperature.

The minimum exposure time period is:

— 14 days (two weeks) for rubber seal materials;

— 42 days (six weeks) for thermoplastic seal materials.

7.11.5 Test procedure

With respect to chemical compatibility, the significant measures for evaluation of suitability of the test material inserted in the component are measured of hardness, volume and weight and visual observations (blisters and tearing).

The following procedure shall be applied (refer to Figure 10):

— the initial rubber hardness, weight and volume of the "as-received" test pieces are measured and recorded;

— the test pieces are placed in the test chamber in such a way that the test pieces are not in contact with each other or with the test chamber wall. The surface of the test pieces shall be completely submerged into the liquid phase of the refrigerant;

— the appropriate amount of lubricant oil is introduced into the test chamber;

— the test chamber is closed and the appropriate amount of refrigerant fluid is introduced into the test chamber;

— the test chamber is subsequently heated to the exposure test temperature and the test conditions are maintained;

— after the exposure time period, the test chamber is allowed to cool down to the ambient temperature and the test pieces are taken out of the test chamber;

— lubricant remains should be removed from the surfaces of each test piece;

— wet state: the hardness, weight and volume of the test pieces are determined within 30 min of removal from the test chamber;

  Elastomers tested with CO_2, can accumulate significant amounts of CO_2. The CO_2 cannot escape immediately when the test items are exposed to atmospheric pressure (de-gassing). Thus, it can create an immediate volume change larger than 25 %. Provided that no surface damage is made, volume change above 25 % is acceptable for CO_2.

— dry state: the test pieces are subsequently degassed in an oven maintained at 50 °C until a constant mass is reached, and the resulting hardness, weight and volume is determined.

NOTE 1 For recovery, reuse and disposal of refrigerants, see ISO 5149-4.

NOTE 2 Additional information can be found in ISO 48-1, ISO 48-2 and ISO 48-4.

7.11.6 Pass/fail criteria for sealing elements

The seal shall meet the following maximum changes after exposure. For change of volume, the application condition (static or dynamic) shall be included.

Maximal acceptable limits given in Table 13 shall be met.

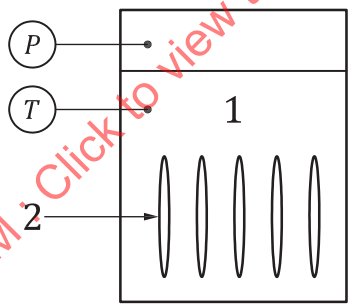
Table 13 — Maximal acceptable limit according to test

Test		Maximal acceptable limit
Hardness change (IRHD)		
	Wet [a]	±15 IRHD
	Dry [b]	±10 IRHD
Volume change (%)		
	Wet	−5 % to +25 %
	Dry	±10 %
Weight (%)		
	Wet	±12 %
	Dry	±7 %

[a] Test shall be performed within 30 min after removal from the exposure vessel.

[b] Material shall be out-gassed/heated (50 °C) to a constant weight prior to testing.

NOTE The above limits for changes in material characteristics caused by exposure to test fluids are maximum values. For specific designs (e.g. dynamic operation), lower values can be required.



Key

1 liquid refrigerant
2 test items
P pressure
T temperature

Figure 10 — Example of testing device

7.12 Fatigue test for hermetically sealed joints

At least five samples shall be provided for this test.

The joint shall be assembled according to the instructions of the manufacturer.

The tightness of the joint shall be ensured by testing.

The samples shall be subjected to a pressure cycle between atmospheric pressure and the maximum allowable pressure, *PS*. The high and low pressure shall be maintained for at least 0,1 s.

The pressure cycle shall be between 20 cycles/min and 60 cycles/min. The total of pressure cycles shall be 250 000 times or more.

After this fatigue test, the joint shall satisfy the test according to 7.4.

The test medium shall be water. Before the tightness test, water shall be totally removed.

8 Test report

The test report shall include at least the following information:

a) a reference to this document (including its year of publication);

b) identification of the sample;

c) test parameters including any deviations from the procedure;

d) number of components/joints to be tested;

e) nature, aspect and assessment of leakages noted at each stage of the test;

f) the test results including any unusual features observed;

g) the date of the test;

h) the name of the laboratory and the signatory of the tests.

9 Information to the user

The component/joint manufacturer shall specify to the user the operating conditions of the component, in particular:

NOTE The user can be an installer, a manufacturer, a maintenance provider and end-user.

a) fluid(s) or type(s) of fluid for which the component/joint or the liaison fits or not;

b) maximal pressure of use;

c) range of minimal/maximal temperatures;

d) procedure and fitting instructions.