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**Testing of valves — Fire type-testing  
requirements**

*Essais des appareils de robinetterie — Exigences de l'essai au feu*

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 10497 was prepared by Technical Committee ISO/TC 153, *Valves*, Subcommittee SC 1, *Design, manufacture, marking and testing*.

This second edition cancels and replaces the first edition (ISO 10497:1992), which has been technically revised.

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## Introduction

This International Standard covers the requirements and method for evaluating the performance of valves when they are exposed to defined fire conditions. The performance requirements establish limits of acceptability of a valve, regardless of size or pressure rating. The burn period has been established to represent the maximum time required to extinguish most fires. Fires of longer duration are considered to be of major magnitude with consequences greater than those anticipated in the test.

The test pressure during the burn is set at 0,2 MPa (2 bar) for soft-seated valves rated PN 16, PN 25 and PN 40, Class 150 and Class 300, to better simulate the conditions that would be expected in a process plant when a fire is detected and pumps are shut down. In this case, the source of pressure in the system is the hydrostatic head resulting from liquid levels in towers and vessels. This situation is approximated by this lower test pressure.

In production facilities, valves are typically of a higher rating and the pressure source is not easily reduced when a fire is detected. Therefore, for all other valves, the test pressure during the burn is set at a higher value to better simulate the expected service conditions in these facilities.

Use of this International Standard assumes that the execution of its provisions is entrusted to appropriately qualified and experienced personnel, because it calls for procedures that may be injurious to health if adequate precautions are not taken. This International Standard refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage of the procedure.

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# Testing of valves — Fire type-testing requirements

## 1 Scope

This International Standard specifies fire type-testing requirements and a fire type-test method for confirming the pressure-containing capability of a valve under pressure during and after the fire test. It does not cover the testing requirements for valve actuators other than manually operated gear boxes or similar mechanisms when these form part of the normal valve assembly. Other types of valve actuators (e.g. electrical, pneumatic or hydraulic) may need special protection to operate in the environment considered in this valve test, and the fire testing of such actuators is outside the scope of this International Standard.

NOTE For the purposes of this International Standard, the terms “fire type-test” and “fire test” are synonymous.

## 2 Normative references

The following referenced documents are indispensable for the application 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 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 10497:2004

IEC 60584-2, *Thermocouples — Part 2: Tolerances*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

### 3.1

#### nominal size

##### DN

alphanumeric designation of size for components of a pipework system, which is used for reference purposes, comprising the letters DN followed by a dimensionless whole number which is indirectly related to the physical size, in millimetres, of the bore or outside diameter of the end connections

[ISO 6708:1995, definition 2.1]

### 3.2

#### nominal pressure

##### PN

numerical designation relating to pressure which is a convenient rounded number for reference purposes, and which comprises the letters PN followed by the appropriate reference number

NOTE 1 It is intended that all equipment of the same nominal size (DN) designated by the same PN number have compatible mating dimensions.

NOTE 2 The maximum allowable working pressure depends on materials, design and working temperatures, and is to be selected from the tables of pressure/temperature ratings given in the appropriate standards.

NOTE 3 Adapted from ISO 7268:1983, Clause 2.

### 3.3

#### **NPS**

alphanumeric designation of size for components of a pipework system, which is used for reference purposes, and which comprises the letters NPS followed by a dimensionless number indirectly related to the physical size of the bore or outside diameter of the end connections

NOTE The number following the letters NPS does not represent a measurable value and is not intended to be used for calculation purposes except where specified in the relevant standard.

### 3.4

#### **Class**

alphanumeric designation used for reference purposes related to a combination of mechanical and dimensional characteristics of a component of a pipework system, which comprises the word "Class" followed by a dimensionless whole number

NOTE The number following the word Class does not represent a measurable value and is not intended to be used for calculation purposes except where specified in the relevant standard.

### 3.5

#### **symmetric seated valve**

valve with an internal construction which has a plane of symmetry perpendicular to the axis of the body ends

NOTE This is a valve where both seat sealing elements are identical.

### 3.6

#### **asymmetric seated valve**

valve with an internal construction which has no plane of symmetry perpendicular to the axis of the body ends

NOTE This is a valve with a single seat offset from the shaft centreline.

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## 4 Test conditions

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### 4.1 Direction and conditions for valves to be tested

4.1.1 Symmetric seated valves intended by the manufacturer for bi-directional installation shall be tested in one direction only.

4.1.2 Asymmetric seated valves intended by the manufacturer for bi-directional installation shall be tested by carrying out the burn test procedure twice, once in each direction of the potential installation.

The same valve may be refurbished and re-tested, or another, identical, valve may be tested in the other direction.

4.1.3 Valves intended solely for unidirectional installation shall be clearly and permanently marked as such and shall be tested in the stated direction of installation.

4.1.4 If the valve being tested is fitted with a gearbox or other such manual device, then only that particular assembly shall qualify. If a valve can be supplied with or without a gearbox, testing with a gearbox fitted shall qualify valves without a gearbox but not the converse.

4.1.5 Valves (and gearboxes) shall not be protected with insulation material of any form during testing, except where such protection is part of the design of the component(s).

### 4.2 Pressure relief provision

If the valve under test incorporates a pressure relief device as part of its standard design and if this device activates during the fire test, then the test shall be continued and any leakage to atmosphere from the device shall be measured and counted as external leakage. If the design is such that the device vents to the



downstream side of the valve, then any leakage shall be counted as through-seat leakage (see 5.6.11 and 5.6.13).

However, the test shall be stopped if the system pressure relief device described in 5.3.2.8 activates.

## 5 Fire test method

### 5.1 General warning

Fire testing of valves is potentially hazardous and it is essential that the safety of personnel be given prime consideration. Given the nature of the fire test and the possibility of weaknesses in the design of the test valve and test equipment, hazardous rupture of the pressure boundary could occur. Adequate shields in the area of the test enclosure and other appropriate means for the protection of personnel are necessary.

### 5.2 Principle

A closed valve completely filled with water under pressure is completely enveloped in flames with an environmental temperature in the region of the valve of 750 °C to 1 000 °C for a period of 30 min. The objective is to completely envelop the valve in flames to assure that the seat and sealing areas are exposed to the high burn temperature. The intensity of the heat input shall be monitored using thermocouples and calorimeter cubes as specified in 5.6.7 and 5.6.8. During this period the internal and external leakage is recorded. After cool-down from the fire test, the valve is hydrostatically tested to assess the pressure-containing capability of the valve shell, seats and seals.

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### 5.3 Apparatus

#### 5.3.1 General

The test equipment shall not subject the valve to externally applied stress affecting the results of the test.

Schematic diagrams of recommended systems for fire type-testing of valves are given in Figure 1.

Potential pipework-to-valve end connection joint leakage is not evaluated as part of the test and is not included in the allowable external leakage (see 6.3 and 6.6). For the purposes of this test, it may be necessary to modify these joints to eliminate leakage.

The test equipment shall be designed so that if the nominal diameter of the pipework situated immediately upstream of the test valve is larger than DN 25 or one-half the DN of the test valve, the pipework shall be enveloped in flames for a minimum distance of 150 mm from the test valve. The diameter of the upstream pipework shall be sufficient to deliver a flow rate in excess of the maximum allowable leak rate for the size of valve being tested.

The pipework downstream of the test valve shall be at least DN 15 and shall be inclined so that the downstream side is fully drained.

The flame source shall be at least 150 mm minimum away from the valve or any calorimeters, and should have sufficient capacity to completely envelop the valve in flames.

The enclosure containing the valve shall provide a horizontal clearance of a minimum of 150 mm between any part of the test valve and the enclosure, and the height of the enclosure above the top of the test valve shall be a minimum of 150 mm.

### 5.3.2 Specific apparatus

**5.3.2.1 Vapour trap** to minimise the cooling effect of the upstream liquid. See Figure 1, (8).

**5.3.2.2 Industrial pressure measurement devices** having a full-scale reading of between 1,5 and 4 times the pressure being measured. The accuracy of each test device used at any point on the scale shall be within 3 % of its maximum scale value for readings taken both up and down the scale with either increasing or decreasing pressure. See Figure 1, (7), (14).

**5.3.2.3 Calorimeter cubes** made of carbon steel in accordance with the design and dimensions shown in Figure 2, with a thermocouple of the accuracy specified in 5.3.2.4, located in the centre of each cube. Calorimeter cubes shall be scale-free before exposure to the fire environment.

**5.3.2.4 Flame environment and valve body thermocouples** of an accuracy at least equal to tolerance class 2 for type B or tolerance class 3 for other types as specified in IEC 60584-2. See Figure 1, (13).

**5.3.2.5 Containers** of a size suitable for collecting the water leaked from the valve under test. See Figure 1, (18).

**5.3.2.6 Calibrated sight gauge** or device for measuring the water used during the test. See Figure 1, (4).

**5.3.2.7 Calibrated device for measuring the leakage water** collected during the test.

**5.3.2.8 Pressure relief provision**, incorporated in the system, consisting of a **pressure relief valve** to relieve the test valve centre cavity pressure to the atmosphere, to protect against potential rupture of the valve if it is designed such that liquid can be trapped in the cavity. See Figure 1, (14).

The pressure relief valve setting shall be

- either that determined by the valve manufacturer from data obtained by hydrostatic pressure testing of valves of the same size and type as the fire-tested valve, or
- when pressure test data is not available, a setting not greater than 1,5 times the maximum permissible working pressure at 20 °C.

### 5.4 Test fluid

The test fluid used shall be water.

### 5.5 Test fuel

The test fuel shall be gaseous.

### 5.6 Procedure

NOTE The numbered items in parentheses refer to the apparatus of Figure 1.

**5.6.1** Mount the test valve in the test apparatus so that the stem and bore of the valve are in the horizontal position. Mount a valve that operates in only one direction (unidirectional) in their normal operating position.

Locate the flame environment, body thermocouples and calorimeter cubes in the positions shown in Figures 3 and 4, as appropriate.

For soft-seated valves up to DN 100 or NPS 4 and pressure ratings up to PN 40, Class 300, use two flame environment thermocouples, two body thermocouples and calorimeter cubes as shown in Figure 3.

For all other valves, use two flame environment thermocouples and two calorimeter cubes as shown in Figure 4. For valves DN 200 or NPS 8 and larger, use a third calorimeter cubes as shown in Figure 4.

**5.6.2** With the test valve in the partially open position, open the water supply valve (5), the shut-off valve (6), the vent valves (16) and the shut-off valve (15) to flood the system and purge the air. When the system is completely filled with water, close the shut-off valve (15), the vent valves (16) and the water supply valve (5). Pressurize the system with water to a test pressure of 1,4 times the maximum permissible working pressure at 20 °C — the actual test pressure may be rounded up to the next highest bar<sup>1)</sup>. Check for leaks in the test apparatus and eliminate as necessary. Release the pressure, close the test valve and open the shut-off valve (15).

**5.6.3** If the valve under test is of the upstream sealing type, determine the volume of water that is trapped between the upstream seat seal and the downstream seat seal when the valve is closed. Record this volume.

It is assumed that, during the fire type-test, this volume of water will flow through the valve and pass the downstream seat seal to be collected in the container (18). Since this volume has not actually leaked through the upstream seat seal, it is deducted from the total volume collected in the downstream container when determining the through-seat leakage (see 5.6.11).

**5.6.4** Pressurize the system to one or the other of the following pressures, as appropriate:

- a) for soft-seated valves rated PN 10, PN 16, PN 25 and PN 40, Class 150 and Class 300, the low test pressure at 0,2 MPa (2 bar);
- b) for all other valves, the high test pressure at 75 % of the maximum permissible seat working pressure at 20 °C.

Maintain this test pressure during the burn and cool-down periods, momentary pressure losses of up to 50 % of the test pressure being permitted provided that the pressure recovers within 2 min and the cumulative duration is less than 2 min.

**5.6.5** Record the reading on the calibrated sight gauge or device (4). Empty the container (18).

**5.6.6** Adjust the test system, excluding the test valve, during the test period to maintain the temperatures and pressures required.

**5.6.7** Open the fuel supply, establish a fire and monitor the flame environment temperature throughout the burn period of 30<sup>+5</sup><sub>0</sub> min. Check that the average temperature of the two flame environment thermocouples (13) reaches 750 °C within 2 min from the start of the burn period, i.e. from ignition of the burners. Maintain the average temperature between 750 °C and 1 000 °C, with no reading less than 700 °C for the remainder of the burn period of 30 min.

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1) 1 bar = 0,1 MPa = 10<sup>5</sup> Pa; 1 MPa = 1 N/mm<sup>2</sup>