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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.

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).

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).

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.

This document was prepared by Technical Committee ISO/TC 153, *Valves*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 69, *Industrial valves,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 10497:2010), which has been technically revised.

The main changes compared are as follows:

— clarification and emphasised importance around the monitoring of cavity pressure during testing for double-seated valves;

— catering for the testing of valves with more than one obturator;

— update of the qualification of other valves by “materials of construction” and inclusion of a new “design” clause;

— accepted fire test certificates of valves tested according to ISO 10497:2010.

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 covers the requirements and method for evaluating the performance of valves when they are exposed to specified fire conditions. The performance requirements establish limits of acceptability of a valve, regardless of size, material 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 10, 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 document assumes that the execution of its provisions is entrusted to appropriately qualified and experienced personnel, because it calls for procedures that can be injurious to health, if adequate precautions are not taken. This document 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.

This document highlights the importance of accurate monitoring and recording of test data during fire testing. The monitoring and measuring of cavity pressure has been emphasised for all double-seated valves. Empirical evidence has shown that the cavity pressure during a fire test can increase significantly unless relieved internally (by design) or externally. Without meeting the minimum requirements of the test report, valves cannot be certified as a fire safe design to this document.

It is recognised by this document that not all combinations of potential trim arrangements can be covered by a single fire test report. Certain design or material differences can be accepted by the purchaser if they do not influence sealing or operating performance. Further clarification on soft materials grouping and bolting has been included in this document.

Valves with more than one obturator are regularly used for in-line isolation and instrumentation service. As such, the need to qualify such designs as fire safe certified is now a common requirement. This document now caters for such valve designs.

Testing of valves — Fire type-testing requirements

1 Scope

This document specifies fire type-testing requirements and a fire type-test method for soft- and metal-seated isolation valves with one or more obturators. It is not applicable to the testing requirements for valve actuators other than manually operated gearboxes or similar mechanisms when these form part of the normal valve assembly. Other types of valve actuators (e.g. electrical, pneumatic or hydraulic) can 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 document.

This document specifies the measurement and assessment criteria for:

a) through-seat leakage;

b) external leakage;

c) cavity overpressure relief of double-seated valves;

d) operability.

This document specifies the rules whereby the fire-type testing qualification for a valve can be extended to untested sizes, pressure ratings and materials of construction of the same basic design type.

Fire test reports of valves tested according to previous editions of this document are acceptable when submitted together with the full and compliant fire test report as per 6.7 of the edition under which it was tested. Any data missing as required from 6.7 within the fire test report are accepted or rejected at the purchaser's discretion.

NOTE For the purposes of this document, the terms "fire type-test" and "fire test" are synonymous.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

[SOURCE: ISO 6708:1995, 2.1, modified — The Notes 1 and 2 to entry have been removed and the term "nominal size" has been added.]

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 to entry: It is intended that all equipment of the same *nominal size (DN)* (3.1) designated by the same PN number have compatible mating dimensions.

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

[SOURCE: ISO 7268:1983, Clause 2, modified — The phrase "and which comprises the letters PN followed by the appropriate reference number" was added.]

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 1 to entry: 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 1 to entry: 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 1 to entry: This is a valve where both seat and 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 1 to entry: This is a valve with a single seat offset from the shaft centreline or containing a twin-seated arrangement where both seats are not identical such as one bidirectional seat and one self-relieving seat.

3.7
soft seat
seat or sealing element made from, or including, thermoplastic, polymeric or elastomeric material which will burn during the fire test

3.8
obturator
movable component of the valve whose position in the fluid flow path permits, restricts or obstructs the fluid flow

3.9
double-seated valve
valve which utilises two seats for each *obturator* (3.8), resulting in a closed pressure sealed cavity, such as a trunnion mounted or floating ball valve, gate valve, plug valve

3.10
isolating valve
valve intended for use only in the closed or fully open position

[SOURCE: EN 736-1:2018, 5.2]

4 Test conditions

4.1 Direction and conditions for valves to be tested

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

4.1.2 Asymmetric-seated valves intended by the manufacturer for bidirectional 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 retested, 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, 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).

4.1.6 For valves with more than one obturator, if all seals and obturators are of the same design, through-seat leak testing of the upstream obturator in a single direction shall qualify all obturators in both directions. Asymmetric valves shall be tested on the upstream block in both directions.

For valves with more than one obturator, a qualified assembly is one where all obturators have been qualified in single valves that use the same obturator and seat/seal design.

If required by the purchaser, tests of a complete manifold assembly shall be subject to agreement between purchaser and manufacturer. The test procedure used shall be agreed by all parties.

The complete assembly, including any auxiliary connections, vents and drains shall be subjected to the fire. The upstream obturator shall be in the closed position and the downstream obturator shall be in the partially open position throughout the test. Testing for external leakage shall be on the complete assembly.

If the valve is comprised of an external vent valve, this shall be in the closed position. All other auxiliary connections shall be blinded sufficiently.

4.2 Pressure relief provision

4.2.1 If the valve under test incorporates a means of relieving cavity pressure as part of its standard design and if this provision activates during the fire test, the test shall be continued and any leakage to atmosphere from the provision shall be measured and counted as external leakage. If the design is such that the provision vents to the downstream side of the valve, any leakage shall be counted as through-seat leakage (see 5.6.11 and 5.6.13).

4.2.2 The test shall be stopped and considered void if the cavity pressure is exceeded which activates the relief valve described in 5.3.2.8.

4.2.3 Double-seated valves tested in compliance with a previous edition of this document where the body cavity relief valve setting and/or cavity pressure during testing was not recorded in the original test report shall be subjected to a supplementary test before claiming compliance with this edition. An overpressure cavity relief test at ambient conditions shall be undertaken to demonstrate the relief performance mechanism of the valve with the test report appended to the original fire test report. Test pressure shall be as specified in 5.3.2.8.

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.

Fire testing shall be void if the product or system fails to perform within the limits specified, except when such failure is determined to be the result of a failure within the test facility or test fixture and that failure and its correction do not affect the validity of the test results.

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.

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 such 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 the valve being tested.

The pipework downstream of the test valve shall be at least DN 15 and shall be inclined such 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 minimize the cooling effect of the upstream liquid. See Figure 1 (7).

NOTE In 5.3.2 the numbered items in parentheses refer to the key numbers for the apparatus in Figure 1.

5.3.2.2 Industrial pressure measurement devices having a full-scale reading of between 1,5 and 4 times the pressure being measured. 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 (6).

5.3.2.3 Calorimeter cubes, of carbon steel in accordance with the design and dimensions shown in Figure 2, with a thermocouple (see 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, at least equal to class 2 for type B or class 3 for other types, as specified in IEC 60584-1. See Figure 1 (11).

5.3.2.5 Containers, of a size suitable for collecting the water leaked from the valve under test. See Figure 1 (16).

5.3.2.6 Calibrated sight gauge, or device for measuring the water volume 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 valve, incorporated in the system, to relieve test valve cavity overpressure due to thermal expansion of test liquid to the atmosphere, to protect against potential rupture, is required for all double-seated valves. For valves with more than one obturator, the connection shall be made into the cavity of the upstream obturator.

The set pressure of the relief valve during the fire test and therefore, the maximum allowable cavity pressure of the valve during the test shall be:

— either that determined by the valve manufacturer from data obtained by hydrostatic cavity overpressure testing of the test valve; proof of this required value is required prior to testing and shall be documented within the report [see 6.7 x)]; or

— when pressure test data are not available, a setting not greater than 1,5 times the maximum allowable pressure at 20 °C.

Cavity pressure during the fire test can rise significantly, increasing the risk of rupture, unless this pressure is relieved. Monitoring of this pressure during the fire test is mandatory for all double-seated valves. Where the introduction of a pressure relief valve would cause significant weakening of the pressure retaining shell and subsequent loss of pressure or integrity, the connection of the pressure relief valve pressure tapping to the test valve body may be suitably locally reinforced to provide adequate strength.

5.4 Test fluid

The test fluid used shall be water.