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Fire protection — Automatic sprinkler systems —

Part 17: Requirements and test methods for pressure reducing valves

Protection contre l'incendie — Systèmes d'extinction automatiques du type sprinkler —

Partie 17: Exigences et méthodes d'essai pour les détendeurs

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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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 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).

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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 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 5, *Fixed firefighting systems using water.*

A list of all parts in the ISO 6182 series can be found on the ISO website.

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.

Fire protection — Automatic sprinkler systems —

Part 17: Requirements and test methods for pressure reducing valves

1 Scope

This document specifies performance requirements, methods of test and marking requirements for pressure reducing valves intended to reduce the downstream water pressure in the piping for water-based fire protection systems. Within the context of this document, pressure reducing valves include both pilot operated pressure reducing valves and direct acting pressure reducing valves. Performance and test requirements for other auxiliary components or attachments to pressure reducing valves are not within the scope of 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 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread*

ISO 898-2, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 2: Nuts with specified property classes — Coarse thread and fine pitch thread*

3 Terms and definitions

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

3.1
corrosion-resistant material
bronze, brass, Monel®[1] metal, austenitic stainless steel, or equivalent, or plastic material conforming with the requirements of this document

1) Monel® is a trademark of Special Metals Corporation and is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product. Equivalent products may be used if they can be shown to lead to the same results.

3.2
direct acting pressure reducing valve
pressure reducing valve utilizing a diaphragm or spring that responds directly to variations in downstream pressure to provide the necessary flow and pressure to a system

Note 1 to entry: Direct acting valves are subject to reduced pressure falloff where a decrease in downstream regulated pressure can occur when the flow increases.

3.3
main valve
part of the valve assembly that controls the flow of water

3.4
minimum opening pressure
pressure at which the valve is intended to start the flow of water

3.5
pilot valve
part of the valve assembly that controls the operating of the *main valve* (3.3)

3.6
pilot operated pressure reducing valve
hydraulically operated pressure reducing valve which reduces the water pressure in a fire protection system to a constant, specific value

Note 1 to entry: A pilot operated pressure reducing valve consists of a *main valve* (3.3) connected to a *pilot valve* (3.5) that is capable of changing the position of the closing mechanism in the valve in response to a change in the pre-set pressure.

3.7
pressure reducing valve
valve designed for the purpose of reducing the downstream water pressure under both flowing and nonflowing conditions

3.8
rated working pressure
maximum service pressure at which a valve is intended to operate

3.9
stuffing box
open area around the valve stem that is filled with the packing seal

4 Requirements

4.1 Nominal sizes and tolerances

4.1.1 The nominal size of a pressure reducing valve shall be the nominal diameter of the inlet and outlet connections, i.e. the pipe size for which the connections are intended. The sizes shall be 40 mm, 50 mm, 65 mm, 80 mm, 100 mm, 125 mm, 150 mm, 200 mm, 250 mm or 300 mm.

4.1.2 Unless otherwise noted in a specific clause or subclause of this document, tolerances shall be in accordance with Annex A.

4.2 Connections

4.2.1 All connections shall be designed for use at the rated working pressure of the valve.

4.2.2 The dimensions of all connections shall conform with the applicable requirements of relevant international standards. If international standards are not applicable, national standards may to be used.

For example, ISO 6182-12 contains requirements for grooved-end components. Where there is not an ISO standard developed, a national standard may be used for other connection types (i.e. threaded, flanged, or other suitable connections).

4.3 Rated working pressure

4.3.1 The rated working pressure shall be not less than 1,2 MPa (12 bar).

4.3.2 Connections may be machined for lower working pressures to match installation equipment provided the valve is marked with the lower working pressure, as per 7.3 f).

4.4 Body and cover

4.4.1 The body and cover shall be made of a material with corrosion resistance at least equivalent to cast iron.

4.4.2 Cover fasteners shall be made of steel, stainless steel, titanium, or other materials with equivalent physical and mechanical properties.

4.4.3 Non-metallic materials other than gaskets, diaphragms and seals or metals with a melting point less than 800 °C shall not form part of the valve body or cover.

4.4.4 It shall not be possible to assemble the valve with the cover plate in a position which either improperly indicates flow direction or prevents proper operation of the valve.

4.5 Strength (see 6.4)

4.5.1 Body (see 6.4.1)

An assembled pressure reducing valve with the sealing assembly blocked open shall withstand, without rupture, an internal hydrostatic pressure of four times the rated working pressure for a period of 5 min when tested as specified in 6.4.1.

If the test is not performed with standard production fasteners, the supplier shall provide documentation showing that the calculated design load of any fastener, neglecting the force required to compress the gasket, shall not exceed the minimum tensile strength specified in ISO 898-1 and ISO 898-2, when the valve is pressurized to four times the rated working pressure. The area of the application of pressure shall be calculated as follows.

a) If a full-face gasket is used, the area of application of pressure is that extending out to a line defined by the inner edge of the bolts.

b) If an "O"-ring seal or ring gasket is used, the area of application of force is that extending out to the centreline of the "O"-ring or gasket.

4.5.2 Diaphragm (see 6.4.2)

All diaphragms used in pressure reducing valves shall not leak, tear or rupture when tested in accordance with 6.4.2.

4.6 Access for maintenance

Means shall be provided to permit access to working parts and removal of the sealing assembly. Any method adopted shall permit ready maintenance by one person.

4.7 Components

4.7.1 Any component of the pressure reducing valve and associated devices that is normally disassembled during servicing shall be designed so that it cannot be reassembled improperly without providing an external visual indication when the valve is returned to service. The main valve servicing shall be possible in-line, without need of dismounting.

4.7.2 With the exception of valve seats, all parts intended for field replacement shall be capable of being disassembled and reassembled using tools normally employed by the trade.

4.7.3 All components shall be non-detachable during normal operation of the valve.

4.7.4 Failure of the sealing assembly diaphragms or seals shall not prevent the valve from opening.

4.7.5 Springs and diaphragms shall not fracture or rupture when tested in accordance with 6.2.

4.7.6 There shall be no sign, on visual examination, of damage to the sealing assembly after testing for the operational requirements of 4.12 in accordance with 6.8.

4.7.7 When wide open, the sealing assembly shall bear against a definite stop. The opening of the valve or reaction of the water shall not permanently twist, bend or fracture valve parts.

4.7.8 Where rotation or sliding motion is required, the part or its bearing shall be made of a corrosion-resistant materials. Materials lacking corrosion resistance shall be fitted with bushings, inserts or other parts made of corrosion-resistant materials at those points where freedom of movement is required.

4.7.9 If an orifice with a diameter less than 5 mm is used in the trim or operation of a valve, a screen or strainer with corrosion resistance equivalent to brass shall be provided. The total area of openings in the screen or strainer shall be not less than 20 times the cross-sectional area of the opening of the screen or strainer it is intended to protect. The largest dimension of the screen or strainer openings shall not exceed 0,8 mm less than the diameter of the protected orifice.

4.7.10 Sealing surfaces of sealing assemblies, including the sealing assembly seat ring, shall have corrosion resistance equivalent to brass or bronze and have sufficient width of surface contact to withstand ordinary wear and tear, rough usage, compression stresses and damage due to pipe scale or foreign matter carried by the water.

4.7.11 Interior bolts or screws shall be made of stainless steel or other material with at least equivalent resistance to corrosion.

4.7.12 An internal spring shall be made of material with corrosion resistance at least equivalent to phosphor bronze.

4.7.13 The pilot trim line used in a pressure reducing valve shall not incorporate a manual shutoff valve that could affect the proper operation of the valve unless the shutoff valve has provisions to be locked in the open position.

4.7.14 A position indicator shall be provided to give visual indication of every position of the disc assembly, or equivalent component, from open to closed.

4.7.15 A means shall be provided for indicating the factory adjustment setting of the valve.

4.7.16 A means shall be provided to lock or seal the pressure reducing valve at the adjusted pressure setting.

4.8 Leakage and deformation (6.3)

4.8.1 There shall be no leakage, permanent distortion or rupture of a valve when tested in accordance with 6.3.1.

4.8.2 There shall be no leakage, permanent distortion or rupture of a valve or sealing assembly when tested in accordance with 6.3.2.

4.8.3 For a direct acting pressure reducing valve when tested as described in 6.3.3, leakage through the unpacked stuffing box or altered stem sealing device of a valve intended to be serviced in the field shall not interfere with the replacement of the packing or seal ring.

4.9 Non-metallic components (excluding gaskets, diaphragms, seals and other elastomeric parts) (see 6.5 and 6.6)

4.9.1 Non-metallic valve parts that affect proper valve function shall be subjected to the applicable ageing of their non-metallic parts as described in 6.5 and 6.6 using separate sets of samples, as applicable. After ageing, a valve shall meet the requirements of 4.8, 4.13 and 4.14 when tested in accordance with the applicable tests described in 6.3, 6.9 and 6.10.

4.9.2 There shall be no cracking, warping, creep, or other signs of deterioration that can prevent proper operation of the valve.

4.10 Sealing assembly elements (see 6.7)

A seal made of elastomeric or other resilient materials shall move off the seat without separation, tearing or permanent distortion when tested in accordance with 6.7. Where the same design of seat is used for more than one size of valve, it shall be permitted to only test the size with the highest stress on the seating surface.

4.11 Clearances

4.11.1 The clearance between a valve disc or a part attached thereto and the inside walls of iron body castings in every position of the valve disc, except fully open, shall be not less than 12,7 mm. This clearance shall be not less than 6,4 mm for valves with bodies of bronze or equivalently corrosion-resistant materials.

4.11.2 For diaphragm operated valves the clearance shall not be less than 2 mm.

4.12 Operation (see 6.8)

A valve shall withstand without malfunction of any part and shall perform in accordance with the manufacturer's specifications when tested in accordance with 6.8. The valve is to be evaluated throughout the rated inlet pressure range, rated outlet pressure range and flow range of the valve during the test.

4.13 Static leakage (see 6.9)

A valve shall withstand for 90 days no leakage from the outlet when tested in accordance with 6.9. Following the test, the valve is then to be subjected to at least three point checks from the data generated during the operation test of 6.8. The values obtained shall not differ by more than 10 % from those obtained with the as-received samples.

4.14 Durability (see 6.10)

The valve shall be tested at the conditions required by 6.10 for 90 minutes without evidence of fluctuation, vibration, or damaging cavitation.

5 Production testing and quality control

5.1 It shall be the responsibility of the manufacturer to implement and maintain a quality control programme to ensure that production continuously meets the requirements of this document in the same manner as the originally tested samples.

5.2 Every manufactured valve shall pass a hydrostatic body test for a period not less than 1 min at twice the rated working pressure without leakage.

5.3 Following the hydrostatic body test in 5.2, every manufactured valve shall pass an operation test to verify that the outlet pressure is within ±5 % of the outlet pressure setting. To conduct the test, the valve is to be set at the outlet pressure marked on the tag specified in 7.3 f). The inlet pressure is to be slowly increased to at least 0,1 MPa (1 bar) above the set outlet pressure. The measured outlet pressure shall be within ±5 % of the outlet pressure setting.

5.4 Every manufactured valve shall withstand, without leakage at the valve seat, an internal hydrostatic pressure of twice the rated working pressure applied upstream of the clapper.

6 Tests

6.1 Samples

A representative sample of each size of valve shall be subjected to the following tests.

6.2 Spring and diaphragm

6.2.1 Spring

6.2.1.1 General

Subject the spring in the normal mounting to 5 000 cycles of normal operation in air or water. The components shall not be operated at a rate exceeding 6 cycles per minute.

6.2.1.2 Sealing assembly

The sealing assembly shall be moved to the 50 % open position and slowly returned to the closed position.

6.2.1.3 Internal bypass

Internal bypass springs shall be operated from the fully open position to the closed position.

6.2.2 Diaphragm

A valve incorporating a diaphragm shall cycle 10 times at 200 % of its maximum set pressure rating without malfunction.

6.3 Leakage and deformation (see 4.8)

6.3.1 Body leakage (see 4.8.1)

Install the valve in a pressure test apparatus with the sealing assembly in the open position. Seal all openings in the valve body. Apply hydrostatic pressure of twice the rated working pressure for a period of 5 min and inspect the valve during this time for signs of leakage. The valve shall conform to the requirements of 4.8.1.

6.3.2 Sealing assembly (see 4.8.2)

Fill the downstream end of the valve with water, while keeping the sealing assembly closed by the application of pressure on the appropriate devices and parts. Isolate these, if necessary, from the upstream end of the valve and keep this end vented.

Increase the hydrostatic pressure to the downstream end from zero to twice the rated working pressure at a rate not exceeding 0,14 MPa/min (1,4 bar/min). Maintain this pressure for 5 min. Examine for leakage, deformation and structural failure. The valve shall conform to the requirements of 4.8.2.

6.3.3 Stem seal and repacking leakage (see 4.8.3)

After completion of the test specified in 6.3.1, the sample is to be fully opened, and the packing in the stuffing box or at least one seal ring of any sealing device is to be removed. The sample, in the fully open position, is to be subjected to the rated pressure for 1 min. Then, with the sample still pressurized, an attempt is to be made to reinsert the packing or seal ring into the stuffing box or sealing device. Leakage through the unpacked stuffing box or altered stem sealing device shall not interfere with the replacement of the packing or seal ring.

6.4 Strength (see 4.5)

6.4.1 Body (see 4.5.1)

For the purpose of this test, production bolts, gaskets and seals may be replaced by components capable of withstanding the test pressure. The valve inlet and outlet connections and all other openings shall be suitably sealed.

There shall be a connection for hydrostatically pressurizing the assembled sample valve set at the inlet connection and a means of venting air and pressurizing fluid at the outlet connection. With the sealing assembly blocked open, the sample valve assembly shall be internally hydrostatically pressurized at four times the rated working pressure, but not less than 4,8 MPa (48 bar), for a period of 5 min. The valve shall conform to the requirements of 4.5.1.

6.4.2 Diaphragms (see 4.5.2)

Diaphragms in the pressure reducing valve or associated devices shall be subjected to a hydrostatic pressure of two times the rated working pressure for 5 min. Following the test, the diaphragms shall meet the requirements of 4.5.2.

6.5 Warm-water ageing test for non-metallic components (excluding gaskets, seals and other elastomeric components) (see 4.9)

Four untested samples of each component shall be immersed in tap water at 87 °C ± 2 °C for 180 days.

If a material cannot withstand the temperature indicated without excessive softening, distortion or deterioration, a water ageing test shall be conducted at a lower temperature, but not less than 70 °C, for a longer period of time. The duration of exposure shall be calculated from Formula (1):

$$t = 74\,857\ e^{-0,069\,3\ T} \quad (1)$$

where

t is the exposure duration, expressed in days;

e is the base of natural logarithms (=2,718 3); and

T is the test temperature, expressed in degrees Celsius.

NOTE This equation is based on the 10 °C rule, i.e. for every 10 °C rise, the rate of a chemical reaction is approximately doubled. When applied to plastic ageing, it is assumed that the life at a temperature, T, in °C is half the life at (T – 10) °C.

The samples shall be removed from the water and allowed to cool to room temperature for examination for a minimum of 24 h. The components shall be examined for cracking, warping, creep or other signs of deterioration which would prevent the proper operation of the device. The parts are then to be assembled into valves and shall conform to the requirements of 4.8.1, 4.13 and 4.14 when tested in accordance with 6.3, 6.9 and 6.10.

6.6 Air ageing test for non-metallic components (excluding gaskets, seals and other elastomeric components) (see 4.9)

Four untested samples of each component shall be aged in an air oven at 120 °C ± 2 °C for 180 days. The samples shall be tested in contact with the mating materials under stresses comparable to the intended use at rated working pressure. The components shall be supported so that they do not touch each other or the sides of the oven.

If a material cannot withstand the temperature indicated without excessive softening, distortion or deterioration, an air ageing test shall be conducted at a lower temperature, but not less than 70 °C, for a longer period of time. The duration of exposure shall be calculated from Formula (2):

$$t = 737\,000\ e^{-0,069\,3\ T} \quad (2)$$

where

t is the duration, expressed in days;

e is the base of natural logarithms (=2,718 3); and

T is the test temperature, expressed in degrees Celsius.

NOTE This equation is based on the 10 °C rule, i.e., for every 10 °C rise, the rate of a chemical reaction is approximately doubled. When applied to plastic ageing, it is assumed that the life at a temperature, T, in °C, is half the life at (T – 10) °C.

The samples shall be removed from the oven and shall be allowed to cool to room temperature for at least 24 h. All post-exposure tests shall be conducted within 72 h. The components shall be examined for cracking, warping, creep or other signs of deterioration which would prevent the proper operation of the device. The parts are then to be assembled into valves and shall conform to the requirements of 4.8.1, 4.13 and 4.14 when tested in accordance with 6.3, 6.9 and 6.10.

6.7 Sealing element tests (see 4.10)

Prior to conducting this test, the minimum opening pressure of the valve needs to be determined.

With the valve in a normal working position and the sealing assembly in the closed position, a hydrostatic pressure of 0,35 MPa (3,5 bar) shall be applied to the outlet end of the valve for a period of 90 days. During this period, the water temperature shall be maintained at 87 °C ± 2 °C by an immersion heater or other suitable heating device. Provisions shall be made to maintain the water in the inlet end of the valve at atmospheric pressure.

Upon completion of this period of exposure, the water shall be drained from the valve and the valve shall be allowed to cool to ambient temperature for at least 24 h. With the outlet end of the valve at atmospheric pressure, a hydrostatic pressure of 0,035 MPa (0,35 bar) above the minimum opening pressure shall be gradually applied to the inlet end of the valve.

6.8 Operation (see 4.12)

6.8.1 Prior to the tests, the pressure reducing valve shall be installed and placed in the operational position according to the manufacturer's instructions. The manufacturer shall provide the anticipated performance data for the full operational range, minimum allowable flow rate for the maximum allowable pressure drop across the valve and maximum allowable flow rate for the minimum allowable pressure drop across the valve.

6.8.2 A sample of the valve is to be connected to a piezometer with a pressure gauge attached and to a water supply that provides the rated working pressure and maximum flow required. A relief valve of not less than 40 mm in size is to be installed on the downstream side of the pressure reducing valve. The pressure relief valve must have an adjustment range of 0,3 MPa (3 bar) or less to 1,4 MPa (14 bar) maximum. The downstream side of the sample is to be fitted with a piezometer equipped with a pressure gauge, piping, and a valve to control the water flow through the sample.

6.8.3 The sample is to be adjusted to obtain the minimum outlet pressure referenced in the installation instructions. The inlet pressure is then to be increased to the minimum inlet pressure recommended by the manufacturer, and the outlet pressure and flow recorded. The inlet pressure is then to be increased in 0,3 MPa (3 bar) increments or less, up to the maximum rated inlet pressure, and the outlet pressure and flow recorded at each increment. Also, at each increment the shutoff valve at the end of the test line that controls the water flow through the sample is to be adjusted to obtain a zero-flow condition and other flow points up to the maximum rated flow. This procedure is then to be repeated at outlet pressures representative of the range recommended by the manufacturer. The recorded outlet pressures at each increment and all flow conditions shall be within ±10 % of the original set pressure, except for the zero-flow condition. The time for the valve to return within ±10 % of the original set pressure shall not exceed 5 s.

6.8.4 After conducting the tests described in 6.8.3, the valve is to be adjusted to yield the highest outlet pressure recommended by the manufacturer. The valve is then to be subjected to the rated inlet pressure while the valve is flowing approximately one-half the maximum flow recommended by the manufacturer. The shutoff valve is to be closed from the open position so as to achieve a no flow condition within 15 s after starting to close the valve. The recorded outlet pressure shall not exceed the maximum outlet pressure recommended by the manufacturer.

6.9 Static leakage (90 days) (see 4.13)

A sample of the valve is to be filled with water in both the outlet and inlet sides and a pipe plug and pressure gauge are to be attached.

The inlet side of the sample is then to be pressurized to at least 1,0 MPa (10 bar), but not more than its rated working pressure and the outlet set at the minimum outlet pressure recommended by the manufacturer. After the 90 day period, the sample is to be subjected to at least three point checks from the data generated during the operation test described in 6.8.

6.10 Durability (see 4.14)

6.10.1 The valve shall be opened and closed 1 000 times under representative pressures and flows. The valve shall continue to operate properly after this test and the leakage requirements specified in 6.3.2 and 6.3.3 shall still apply.

6.10.2 Representative flows and pressures must include:

a) the manufacturer's recommended minimum allowable flow rate for the maximum allowable pressure drop; and

b) the maximum allowable flow rate for the minimum allowable pressure drop.

7 Marking

7.1 Pressure reducing valves shall be marked either directly on the body with raised or depressed cast letters, or on a permanent metal label attached mechanically (such as with rivets or screws). Metal labels shall be made of corrosion-resistant materials.

7.2 Cast body markings shall be in letters and figures at least 9,5 mm high. The height of the marking may be reduced to 5 mm for 50 mm and smaller valves. Cast body letters and figures shall be raised or depressed by at least 0,75 mm.

The letters on an etched or stamped permanent label shall be a minimum of 2 mm high.

7.3 Pressure reducing valves shall be marked with:

a) The name or trademark of the manufacturer or vendor.

b) The distinctive model number, catalogue designation or an equivalent marking.

c) The name of the device, such as "Pressure Reducing Valve".

d) An indication of flow direction, or

e) the nominal size (inlet).

f) The working pressure in MPa (or bar). If connections are machined for lower working pressures than those listed in 4.3.2, the lower pressure limit shall be marked.

g) The serial number or year of manufacture. Valves produced in the last three months of a calendar year may be marked with the following year as the date of manufacture; valves produced in the first six months of a calendar year may be marked with the previous year as the date of manufacture.

h) The mounting position, if limited to vertical or horizontal position.

i) "Open", and "Closed" (or "Shut") shall be cast or stamped in the proximity of the position indicator. The indicator shall point to these words when the valve is fully open or closed.

j) The factory of origin, if manufactured at two or more factories.

8 Manufacturer's installation instructions

A copy of the installation instructions shall be made available for each pressure reducing valve.

The installation instructions shall include:

a) Identification of models and sizes covered by the instructions.

