
**Safety and control devices for oil burners
and oil-burning appliances — Particular
requirements —**

Part 1:
Shut-off devices for oil burners

*Dispositifs de commande et de sécurité pour brûleurs à fioul et pour
appareils à fioul — Exigences particulières —*

Partie 1: Dispositifs de coupure pour brûleurs à fioul



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Published in Switzerland

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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 23553-1 was prepared by Technical Committee ISO/TC 161, *Control and protective devices for gas and oil burners and gas and oil burning appliances*.

ISO 23553 consists of the following parts, under the general title *Safety and control devices for oil burners and oil-burning appliances* — *Particular requirements*:

— *Part 1: Shut-off devices for oil burners*

Safety and control devices for oil burners and oil-burning appliances — Particular requirements —

Part 1: Shut-off devices for oil burners

1 Scope

This part of ISO 23553 specifies safety, constructional and performance requirements, and testing of safety shut-off devices, for liquid fuels.

This part of ISO 23553 covers type testing only.

It applies to safety shut-off devices which:

- are designed as e.g. automatic valves or fast-closing devices;
- are used in combustion plants to interrupt the flow of liquid fuels with or without delay on closing and with or without delay on opening;
- are for use with fuel oils;

NOTE For other liquid fuels, additional test methods can be agreed between the manufacturer and the test authority.

- form part of a device having other function(s), such as oil pumps. In this case the test methods apply to those parts or components of the device forming the safety shut-off device, i.e. those parts which are necessary for the closing function;
- have declared maximum working pressures up to and including 5 000 kPa, for use on burners or in appliances using liquid fuels;
- are directly or indirectly operated electrically or by mechanical or hydraulic means;
- are fitted with or without closed-position indicator switches.

The methods of test given in this part of ISO 23553 are intended for product type testing.

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 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 1817:2005, *Rubber, vulcanized — Determination of the effect of liquids*

ISO 7005-1, *Pipe flanges — Part 1: Steel flanges for industrial and general service piping systems*

ISO 7005-2, *Metallic flanges — Part 2: Cast iron flanges*

ISO 7005-3, *Metallic flanges — Part 3: Copper alloy and composite flanges*

ISO 23550:2004, *Safety and control devices for gas burners and gas-burning appliances — General requirements*

ISO 23551-1:2006, *Safety and control devices for gas burners and gas-burning appliances — Particular requirements — Part 1: Automatic valves*

IEC 60529:2001, *Degrees of protection provided by enclosures (IP Code)*

IEC 60534-1, *Industrial-process control valves — Part 1: Control valve terminology and general considerations*

IEC 60534-2-3, *Industrial-process control valves — Part 2-3: Flow capacity — Test procedures*

IEC 60730-1:1999, *Automatic electrical controls for household and similar use — Part 1: General requirements*

EN 1057, *Copper and copper alloys — Seamless, round copper tubes for water and gas in sanitary and heating applications*

3 Terms and definitions

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

- 3.1 safety shut-off device**
device for shutting off the fuel flow in order to avoid dangerous operating conditions in a plant
- 3.2 closure member**
movable part of the control which shuts off the oil flow
- 3.3 breather hole**
orifice which allows atmospheric pressure to be maintained within a compartment of variable volume
- 3.4 external leak-tightness**
leak-tightness of a oil-carrying compartment with respect to the atmosphere
- 3.5 internal leak-tightness**
leak-tightness of the closure member (in the closed position) sealing an oil-carrying compartment with respect to another compartment or to the outlet of the control
- 3.6 inlet pressure**
pressure at the inlet of the safety shut-off device

3.7**outlet pressure**

pressure at the outlet of the safety shut-off device

3.8**maximum working pressure****maximum operating pressure**

highest inlet pressure declared by the manufacturer at which the safety shut-off devices may be operated

3.9**minimum working pressure**

lowest inlet pressure declared by the manufacturer at which the safety shut-off devices may be operated

3.10**flow rate**

volume flowing through the safety shut-off devices per unit time

3.11**rated flow rate**

air flow rate at a specified pressure difference declared by the manufacturer, corrected to standard conditions

3.12**maximum ambient temperature**

highest temperature of the surrounding air declared by the manufacturer at which the control may be operated

3.13**minimum ambient temperature**

lowest temperature of the surrounding air declared by the manufacturer at which the control may be operated

3.14**mounting position**

position declared by the manufacturer for mounting the safety shut-off devices

3.15**nominal size****DN**

numerical designation of size, for reference purposes, loosely related to manufacturing dimensions, common to all components in a piping system

NOTE

The abbreviation DN stands for *diamètre nominal*, in French.

3.16**nominal pressure****PN**

numerical designation of pressure for reference purposes, related to the maximum working pressure, common to all components in a piping system

NOTE

The abbreviation PN stands for *pression nominale*, in French.

3.17**differential pressure**

difference between the inlet and outlet pressures

3.18**fast-closing device**

safety shut-off device with a predetermined time for the closing process

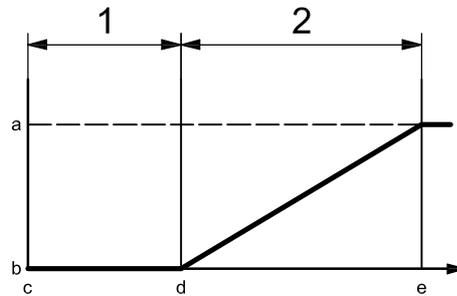
3.19**response times**

3.19.1 opening time

time from the beginning until the end of the change in position of the closure member from the closed to the open position

See Figure 1.

NOTE See also 3.13 of ISO 23551-1:2006.



Key

- 1 delay time
- 2 opening time
- a open
- b closed
- c signal for opening
- d start of period of change in position
- e end of period of change in position

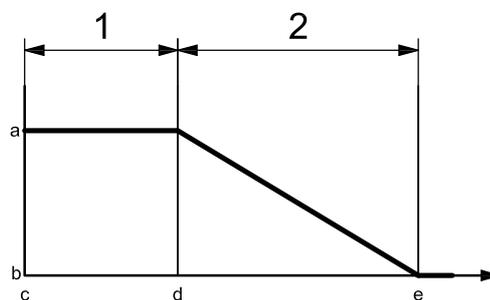
Figure 1 — Response time of closure member during opening

3.19.2 closing time

time from the beginning until the end of the change in position of the closure member from the open to the closed position

See Figure 2.

NOTE See also 3.14 of ISO 23551-1:2006.



Key

- 1 delay time
- 2 closing time
- a open
- b closed
- c signal for closing
- d start of period of change in position
- e end of period of change in position

Figure 2 — Response time of closure member during closing

3.19.3**delay time**

⟨opening⟩ interval between the signal to open and the point at which the closure member no longer maintains the required tightness according to 7.2.1.2

See Figure 1.

NOTE See also 3.15 of ISO 23551-1:2006.

3.19.4**delay time**

⟨closure⟩ the interval between the signal to close and the start of change in position of the closure member

See Figure 2.

3.20**opening force**

force which effects the opening of the safety shut-off device

3.21**closing force**

force which effects the closing of the closure member in the case of failure or interruption of the externally applied actuating energy, such as spring force, independent of any force provided by fuel oil pressure

3.22**frictional force**

largest force required to move the actuating mechanism and the closure member from the open position to the closed position with the closing force removed, independent of any force provided by fuel oil pressure

NOTE Adapted from 3.10 of ISO 23551-1:2006.

3.23**opening [closing] characteristics**

curve representing the movement of the closure member against time on opening [closing]

3.24**actuator**

part effecting the movement of the closure member

EXAMPLE Valve disc

3.25**auxiliary medium**

medium used for actuating the moving parts of the system (pneumatic or hydraulic)

3.26**auxiliary medium pressure**

pressure exerted by the auxiliary medium during actuation of the moving parts

3.27**direct-flow valve**

valve in which the medium, in the valve seat, flows in the direction of the closure member for shutting off the flow

4 Classification

4.1 Classes of shut-off device

4.1.1 According to the method of operation

The following three types are in this class:

- a) safety shut-off device which is opened by hand, held open by auxiliary energy and closed by interruption or failure of the auxiliary energy;
- b) safety shut-off device according to a), which may, however, also be closed by hand;
- c) safety shut-off device which is opened and held open by auxiliary energy and closed by interruption or failure of the auxiliary energy.

4.1.2 According to the installation

The following two types are in this class:

- a) for indoor use;
- b) for outdoor use.

4.2 Control groups

Controls are grouped according to the bending stress which is specified for testing (see 7.3).

- a) Group 1 controls

Controls for use in an appliance or installation where they are not subjected to bending stresses imposed by installation pipework (e.g. safety shut-off device being a part of the pump).

- b) Group 2 controls

Controls for use in any situation, either internal or external to the appliance, typically without support.

NOTE Controls which meet the requirements of a Group 2 control also meet the requirements of a Group 1 control.

5 Test conditions

Tests shall be carried out at an ambient temperature of (20 ± 5) °C, unless otherwise specified.

Tests shall be carried out in the mounting position declared by the manufacturer. If there are several mounting positions, tests shall be carried out in the least favourable position.

If no specific methods of test are given, conformity with these requirements shall be verified by inspection and/or measurement.

6 Construction

6.1 General

Safety shut-off devices shall be designed, manufactured and assembled so that the various functions operate correctly when installed and used according to the manufacturer's instructions.

All pressurized parts of a control shall withstand the mechanical and thermal stresses to which they are subjected without any deformation affecting safety.

When reference is made in this part of ISO 23553 to ISO 23550, the word "gas" shall be replaced by "oil".

6.2 Construction requirements

6.2.1 Appearance

The requirements in subclause 6.2.1 of ISO 23550:2004 apply.

6.2.2 Holes

The requirements in subclause 6.2.2 of ISO 23550:2004 apply.

6.2.3 Breather holes

The requirements in subclause 6.2.3 of ISO 23550:2004 do not apply.

6.2.4 Screwed fastenings

The requirements in subclause 6.2.4 of ISO 23550:2004 apply.

6.2.5 Jointing

The requirements in subclause 6.2.5 of ISO 23550:2004 apply.

6.2.6 Moving parts

The requirements in subclause 6.2.6 of ISO 23550:2004 apply.

6.2.7 Sealing caps

The requirements in subclause 6.2.7 of ISO 23550:2004 do not apply.

6.2.8 Dismantling and reassembling for servicing and/or adjustment

Parts which are intended to be dismantled for servicing or adjustment shall be capable of being dismantled and reassembled using commonly available tools. They shall be constructed or marked in such a way that incorrect assembly is impossible when following the manufacturer's instructions.

Closure parts, including those of measuring and testing points, which can be dismantled for servicing or adjustment, shall be constructed such that leak-tightness is achieved by mechanical means (e.g. metal-to-metal joints, O-rings) without using jointing compounds such as liquids, pastes or tapes.

6.2.9 Auxiliary channels

Blockage of auxiliary channels and orifices shall not adversely affect the operation of the control, otherwise they shall be protected against blockage by suitable means.

6.2.10 Resistance against pressure

The components of safety shut-off devices for fuel oil shall be designed for pressures of 1,5 times the system design pressure, while the safety shut-off device is in the open position, and where the operating pressure has been adjusted to the maximum permissible value.

The mechanical strength for devices above PN 16 or above DN 80 shall be proven.

6.2.11 Manually adjustable packing glands

Manually adjustable packing glands are not permitted.

6.2.12 Non-metallic sealing materials

Non-metallic sealing materials in contact with the fuel shall be heat-resistant within the temperature range indicated by the manufacturer and at least from 0 °C to 60 °C.

6.2.13 Connections

The connections shall be designed in such a way that the safety shut-off devices can be installed in the fuel lines by welding, brazing, with flanges using suitable gaskets, or by threads.

Threaded connections shall be designed in such a way that a tight joint can be achieved without the use of hemp or sealing tape.

6.3 Materials

6.3.1 General material requirements

The quality of materials, the dimensions used and the method of assembling the various parts shall be such that construction and performance characteristics are safe. Performance characteristics shall not alter significantly over a reasonable lifetime when installed and used according to the manufacturer's instructions. Under these circumstances, all components shall withstand any mechanical, chemical and thermal conditions to which they may be subjected during service.

6.3.2 Housing

6.3.2.1 Housing design

Parts of the housing which directly or indirectly separate an oil-carrying compartment from atmosphere shall either

- be made from metallic materials, or
- on removal or fracture of non-metallic parts (other than O-rings, gaskets, seals and the sealing part of diaphragms), air leakage rate at the maximum working pressure shall be no greater than $30 \text{ dm}^3 \cdot \text{h}^{-1}$.

6.3.2.2 Test for leakage of housing after removal of non-metallic parts

Remove all non-metallic parts of the housing which separate the oil-carrying compartment from the atmosphere (excluding O-rings, seals, gaskets and the sealing part of diaphragms). Any breather holes shall be blocked. Pressurize the inlet and outlet(s) of the control to the maximum working pressure and measure the leakage rate.

Air leakage rate at the maximum working pressure shall be no greater than $30 \text{ dm}^3 \cdot \text{h}^{-1}$.

6.3.3 Components generating or transmitting the closure force

6.3.3.1 Closure springs

Closure springs shall be calculated and designed in such a way as to withstand oscillating loads and at least 10^6 operations.

If a satisfactory calculation cannot be submitted to the test laboratory, the springs shall be subjected to an endurance test of 2×10^6 operations under normal operating conditions.

6.3.3.2 Components other than springs

With the exception of closure springs (see 6.3.3.1), components generating or transmitting the closure force, including components of the actuator, shall be designed such that the breaking load is five times the maximum possible operating load. Deviations from this requirement are acceptable if the function is not rendered unsafe upon fracture of the component and if tightness is maintained.

6.3.4 Resistance to corrosion and surface protection

The requirements in subclause 6.3.4 of ISO 23550:2004 do not apply.

6.3.5 Impregnation

If impregnation is part of the manufacturing process for parts which effect the tightness of the safety shut-off device, it shall be carried out using an appropriate procedure (e.g. vacuum or internal pressure, using appropriate sealing materials).

6.3.6 Seals for glands for moving parts

Seals for moving parts which pass through the body to atmosphere and seals for closure members shall be made only of solid, mechanically stable materials which do not deform permanently. Sealing paste shall not be used.

Manually adjustable packing glands shall not be used for sealing moving parts.

Bellows shall not be used as the sole sealing element against atmosphere.

NOTE An adjustable gland set by the manufacturer and protected against further adjustment is considered to be non-adjustable.

6.3.7 Actuators

6.3.7.1 Electromagnetic actuators

Electromagnetic actuators shall remain functional in the range of 85 % to 110 % of the rated voltage.

The actuators shall be designed in such a way that, after an uninterrupted operation of more than 350 h at a rated voltage of 100 %, and at the maximum permissible ambient temperature, the force of retention (e.g. due to friction or remanence) does not prevent that

- a) the automatic closing of the closure member shall occur at a voltage not below 30 % of the rated voltage, or
- b) for direct-flow valves, the automatic closing of the closure member shall occur at a voltage not below 15 % of the rated voltage if, in addition a force of at least 0,4 N per mm length of the sealing edge up to a nominal size DN 4 and over DN 4 a force of at least $(20 + 5 d) \times 10^{-2}$ N per mm edge length is ensured (where d is the diameter of the valve seat).

For electrically operated control valves (pilot valves), automatic closure shall occur at a voltage not below 15 % of the rated voltage.

6.3.7.2 Pneumatic actuators

Pneumatic actuators shall open and close the safety shut-off devices correctly at the highest operating pressure while at the lowest permissible auxiliary medium pressure. The necessary control pipes or nozzles shall be chosen such that their function is guaranteed. Control devices for pneumatic actuators, e.g. electromagnetic valves, shall be treated as part of the fast-closing device according to this part of ISO 23553.

Control valves may be exchanged without further testing, if the replacement valves have been previously approved as part of a type test to this part of ISO 23553.

6.3.7.3 Hydraulic actuators

Hydraulic actuators shall be in accordance with 6.3.7.2, as applicable.

6.4 Oil connections

6.4.1 Making connections

The control housing shall be designed to accept commonly available tools in making all oil connections, e.g. by the provision of suitable spanner flats.

6.4.2 Connection sizes

Equivalent connection sizes are given in Table 1.

Table 1 — Equivalent connection sizes

Thread or flange nominal size	Thread or flange diameter	Compression fitting tube — Range of outside diameter
DN	inches	mm
6	1/8	2 to 5
8	1/4	6 to 8
10	3/8	10 to 12
15	1/2	14 to 16
20	3/4	18 to 22
25	1	25 to 28
32	1 1/4	30 to 32
40	1 1/2	35 to 40
50	2	42 to 50

6.4.3 Threads

Inlet and outlet threads shall be in accordance with ISO 7-1 or ISO 228-1 and shall be chosen from the series given in Table 1.

Inlet and outlet connections shall be designed so that when a pipe which is threaded two threads beyond standard size (for the size in question) is run into the threaded portion of a control body, it will not adversely affect the operation of the control. A stop for the thread will also satisfy the requirement.

NOTE In the USA, threads are required to comply with the national pipe thread taper, see ANSI/ASME B1.20.1.

6.4.4 Union joints

If connections are made with union joints, either the joints shall be included with the control or full details shall be supplied if the threads do not conform to ISO 7-1 or ISO 228-1.

6.4.5 Flanges

If flanges are used on controls up to and including DN 50 which are not suitable for connection to flanges in accordance with the ISO 7005 series, either suitable adapters shall be supplied to enable connection to standard flanges and threads, or full details of mating parts shall be supplied.

6.4.6 Compression fittings

Compression fittings shall be suitable for use with tubes of outside diameter according to EN 1057. It shall not be necessary to form the tubes before making connections. Olives shall be appropriate to the tubes for which they are intended. Non-symmetrical olives may be used provided they cannot be fitted incorrectly.

6.4.7 Nipples for pressure tests

Nipples for pressure tests shall have an external diameter of $(9_{-0,5}^0)$ mm and a useful length of at least 10 mm for connection to tubing. The equivalent diameter of the bore shall not exceed 1 mm.

6.4.8 Strainers

Each safety shut-off device shall be equipped with a strainer to prevent the penetration of large particles. If two devices (e.g. 2 fast-closing devices, or 1 fast-closing device in conjunction with 1 other safety shut-off device or a pump with integral safety shut-off device) are combined as a group with or without intermediate pipes. One built-in strainer before or in the first device is sufficient. The mesh size of the screen shall not exceed 0,5 mm. Regarding testing, the strainer shall be treated as a component of the device. It should be designed and arranged such that in case of deformation the function of the device is not affected.

6.4.9 Position indicator

The closed position of safety shut-off devices with position indicator [type "s", see 9.1 f)] shall be marked on the valve, which shall be fitted with a potential-free pair of contacts.

6.5 EMC and electrical requirements

Compliance shall be tested in accordance with Clause 8.

6.5.1 General

Electrical components such as solenoids, contacts, and motorized drives shall conform to ISO 23550:2004, 8.11.

The minimum degree of protection shall be IP 40 in accordance with IEC 60529, with the exception of parts installed separately from the safety shut-off device (e.g. in a switch room or in a cabinet). For outdoor equipment, the degree of protection shall be at least IP 65.

6.5.2 EMC requirements

Safety shut-off devices shall meet the following EMC requirements:

- a) For interruptions and decreases up to and including 20 ms, the device shall conform to the functional requirements of this part of ISO 23553 and shall not show any significant change in flow. For interruptions and decreases exceeding 20 ms, the valve shall operate safely.
- b) For safety shut-off devices which include as electrical components only one coil with or without additional protection components such as VDR and capacitor, ISO 23550:2004, 8.1 to 8.5 only are applicable.
- c) For safety shut-off devices which include as electrical and electronic components more than one coil with or without additional protection components, such as VDR and capacitor, ISO 23550:2004, Clause 8 and Annex D are applicable.
- d) At level 2 of the above-mentioned tests, the valve shall not be influenced and shall conform to the functional requirements of this part of ISO 23553. At level 3, the valve shall not show any unspecified functional behaviour and shall be able to shut off the flow of fuel oil.

6.5.3 Power-saving circuits

Valves with power-saving circuits shall be designed such that any fault in the power-saving circuit does not affect the correct closing of the valve.

If the power-saving circuit has been reviewed in accordance with IEC 60730-1 on a second fault analysis, the test under ISO 23551-1:2006, 8.14 does not apply.

7 Performance

7.1 General

Controls shall operate correctly under all combinations of the following:

- the full range of working pressures;
- the ambient temperature range from 0 °C to 60 °C, or wider limits if declared by the manufacturer;
- in the mounting position declared by the manufacturer.

If several mounting positions are declared, tests shall be made in the least favourable position to check conformity to this requirement.

Additionally, for electrically operated controls:

- the voltage or current range, from 85 % to 110 % of the rated value or from 85 % of the minimum rated value to 110 % of the maximum rated value.

7.2 Leak-tightness

7.2.1 Criteria

Safety shut-off devices shall be leak-tight.

7.2.1.1 External leak-tightness

Safety shut-off devices are considered to be externally leak-tight if the requirements given in 7.2.2.2 are fulfilled.

7.2.1.2 Internal leak-tightness

Safety shut-off devices shall close tightly at all differential pressures. The test shall be carried out according to 7.2.2.3. They are considered to be internally leak-tight if the leakage rates given in Table 2 are not exceeded.

Closure parts shall remain leak-tight after dismantling and reassembly (see 6.2.8).

Table 2 — Internal leak-tightness

Nominal inlet size DN	Maximum leakage rates of test medium cm ³ · h ⁻¹
DN < 10	1
10 ≤ DN ≤ 25	2
25 < DN ≤ 50	4
over DN 50	8

NOTE Regional specific requirements for Japan are given in Annex A.

7.2.2 Test for leak-tightness

7.2.2.1 General

The test is carried out in the as-supplied condition and after the endurance test of 7.7.

The test medium used for safety shut-off devices for all types of fuel oil is a distillate at a temperature of approximately 20 °C and having the following characteristics:

- flashpoint: minimum 40 °C;
- initial boiling point: maximum 180 °C.

7.2.2.2 External leak-tightness

The test shall be performed at 1,5 times the operating pressure.

The test shall be made with the safety shut-off device in the open position.

The test duration at each appropriate test pressure shall be 24 h. The temperature of the test sample shall be recorded during the test.

Compliance is verified by inspection. At the end of the test, the outer surface of the valve shall not show any leakage.

Dismantle and reassemble closure parts five times in accordance with the manufacturer's instructions, and repeat the test.

7.2.2.3 Internal leak-tightness

The leak-tightness test shall be performed at 1,0 times, 0,3 times and 0,1 times the differential pressure.

The test shall be performed with the safety shut-off device in the closed position. The test shall be made using operating pressure with forward flow:

The test duration at each appropriate test pressure shall be at least 1 h. The temperature of the test sample shall be recorded during the test.

During the test, the leakage rates shall not exceed those given in Table 2.

7.3 Torsion and bending

7.3.1 General

Controls shall be constructed so as to have adequate strength to withstand any mechanical stress to which they may be subjected during installation and service.

After testing, there shall be no permanent deformation, and any leakage shall not exceed the values given in Table 2 or in the specific control standard.

NOTE For regional specific requirements, see Annex A.

7.3.2 Torsion and bending tests

Carry out the tests in accordance with ISO 23550:2004, 7.3.4.

7.4 Flow capacity

7.4.1 Criteria

If flow capacity of the shut-off device is used as a safety criterion, the flow capacity K_V or C_V shall be used according to IEC 60534-1. The maximum flow capacity, measured according to 7.7, shall be at least 0,95 times the nominal flow capacity stated by the manufacturer.

7.4.2 Test of flow capacity

The flow capacity shall be tested in the open position in accordance with IEC 60534-2-3.

7.5 Durability

7.5.1 Material in contact with oil

Material in contact with oil (e.g. valve pads, O-rings, diaphragms and lip seals) shall be homogeneous, free from porosity, inclusions, grit, blisters and other surface imperfections visible to the naked eye.

7.5.2 Resistance to lubricants

The resistance to lubricants of elastomers shall be tested according to 7.5.3. The resulting change in mass shall not be greater than $\pm 10\%$.

7.5.3 Test for resistance to lubricants

Carry out the test with the finished component or with parts of the finished component according to 7.2 of ISO 1817:2005 using the gravimetric method, with a duration of immersion of (168 ± 2) h in oil No. 2 at the maximum declared ambient temperature of the control.

Determine the relative change of mass, Δm , using Equation (1):

$$\Delta m = \frac{m_2 - m_1}{m_1} \times 100 \quad (1)$$

where:

m_1 is the initial mass of the test piece in air;

m_2 is the mass of the test piece in air after immersion.

7.5.4 Marking resistance

7.5.4.1 General

Adhesive labels and all marking shall be tested for resistance to abrasion, humidity and temperature. They shall neither lift nor discolour such that the marking becomes illegible.

Specifically, markings on knobs shall survive the continual handling and rubbing resulting from manual operation.

7.5.4.2 Tests for marking resistance

Carry out the tests according to the methods given in IEC 60730-1:1999, Annex A.

7.5.5 Resistance to scratching

The requirements in subclause 7.8.8 of ISO 23550:2004 apply.

7.5.6 Resistance to humidity

The requirements in subclause 7.8.10 of ISO 23550:2004 apply.

7.6 Functional requirements

7.6.1 Safety shut-off devices shall open and close without delay, or with delayed action in accordance with the response time(s) declared by the manufacturer.

7.6.2 Safety shut-off devices shall always close tightly in accordance with their mode of operation (see 4.1.1).

7.6.3 For fast-closing devices, the sum of the delay and closing times shall not exceed 1 s.

7.7 Endurance

7.7.1 General

The test sample shall be submitted to a functional test to the requirements given in 6.1 to 6.3 and 7.6 before and after the endurance test of 7.7.2.

After the endurance test, the safety shut-off device shall operate correctly at an ambient temperature of 60 °C as well as at the minimum admissible working pressure.

7.7.2 Test of endurance

An endurance test at the permissible operating pressure shall be carried out on the test sample, using the auxiliary medium with which the device is intended to be used. The number of cycles to be completed in the test is as follows:

for sample installations up to and including DN 15: 5×10^5 cycles

for sample installations above DN 15: 5×10^4 cycles

The endurance test shall be carried out at 0 °C and at +60 °C for all kinds of fuel oil, with 50 % of the appropriate number of cycles at each temperature.

If fast-closing devices are to be used outside the above-mentioned temperature range, this shall be taken into account during the test.

NOTE Regional specific requirements for Japan are given in Annex A.

8 EMC test

The EMC/electrical requirements in Clause 8 and Annex D of ISO 23550:2004 apply, if relevant electrical components or circuits are a part of the safety shut-off devices.

For safety shut-off devices consisting of a coil with additional protection components such as VDR and capacitor, only subclauses 8.1 to 8.5 of ISO 23550:2004 apply.

The test levels given in this part of ISO 23553 are for general applications and environments. To ensure the safe use of gas in harsher environments, only Criterion I should be used.

a) **Assessment Criterion I:**

When tested at the severity levels given in 8.2 to 8.9 of ISO 23550:2004, the safety shut-off device shall continue to function in accordance with 6.5.2 and 6.5.3, if applicable.

b) **Assessment Criterion II:**

When tested at the severity levels given in 8.2 to 8.9 of ISO 23550:2004, the safety shut-off device shall continue to function in accordance with the last paragraph of 6.5.2 and 6.5.3, if applicable.

9 Marking, installation and operating instructions

9.1 Marking

Safety shut-off devices shall exhibit appropriate durable markings in a clearly visible position on the housing or on a nameplate, providing at least the following information:

- a) manufacturer's mark;
- b) flow direction of the medium;
- c) operating temperature:
 - 0 °C to 60 °C: no temperature indication,
 - outside the range 0 °C to 60 °C: indication of temperature;
- d) maximum operating pressure:

If the safety shut-off device shall be used only in connection with appliances within the operating pressure limits, no marking is necessary;
- e) where necessary, further marking on the housing:
 - nominal voltage, in volts,
 - symbol for the type of current,
 - nominal frequency, in hertz,
 - if in excess of 25 W, nominal power consumption, in watts, or nominal current, in amperes,
 - degree of protection;
- f) additional marking as appropriate:
 - "nc" if valve is closed,
 - "s" if a position indicator (see 6.4.9) is fitted;
- g) type reference;
- h) auxiliary medium, and minimum and maximum auxiliary medium pressures;
- i) conformity mark.