INTERNATIONAL STANDARD

ISO 4126-4

Second edition
2013-07-15

Safety devices for protection against excessive pressure —

Part 4: Pilot operated safety valves

Dispositifs de sécurité pour protection contre les pressions excessives —

Partie 4: Soupapes de sûreté pilotées

Reference number
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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 4126-4 was prepared by Technical Committee ISO/TC 185, *Safety devices for protection against excessive pressure*.

This second edition cancels and replaces the first edition (ISO 4126-4:2004), which has been technically revised. It also incorporates the Technical Corrigendum ISO 4126-4:2004/Cor 1:2007.

ISO 4126 consists of the following parts, under the general title *Safety devices for protection against excessive pressure*:

— *Part 1: Safety valves*

— *Part 2: Bursting disc safety devices*

— *Part 3: Safety valves and bursting disc safety devices in combination*

— *Part 4: Pilot-operated safety valves*

— *Part 5: Controlled safety pressure relief systems (CSPRS)*

— *Part 6: Application, selection and installation of bursting disc safety devices*

— *Part 7: Common data*

— *Part 9: Application and installation of safety devices excluding stand-alone bursting disc safety devices*

— *Part 10: Sizing of safety valves for gas/liquid two-phase flow*

— *Part 11: Performance testing*[1)]

Part 7 contains data that is common to more than one of the parts of ISO 4126 to avoid unnecessary repetition.

1) Under development.

Safety devices for protection against excessive pressure —

Part 4:
Pilot operated safety valves

1 Scope

This part of ISO 4126 specifies general requirements for pilot operated safety valves, irrespective of the fluid for which they are designed. In all cases, the operation is carried out by the fluid in the system to be protected.

It is applicable to pilot operated safety valves having a valve flow diameter of 4 mm and above which are for use at set pressures of 0,1 bar gauge and above. No limitation is placed on temperature.

This is a product standard and it is not applicable to applications of pilot operated safety valves.

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 4126-7:2013, *Safety devices for protection against excessive pressure — Part 7: Common data*

3 Terms and definitions

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

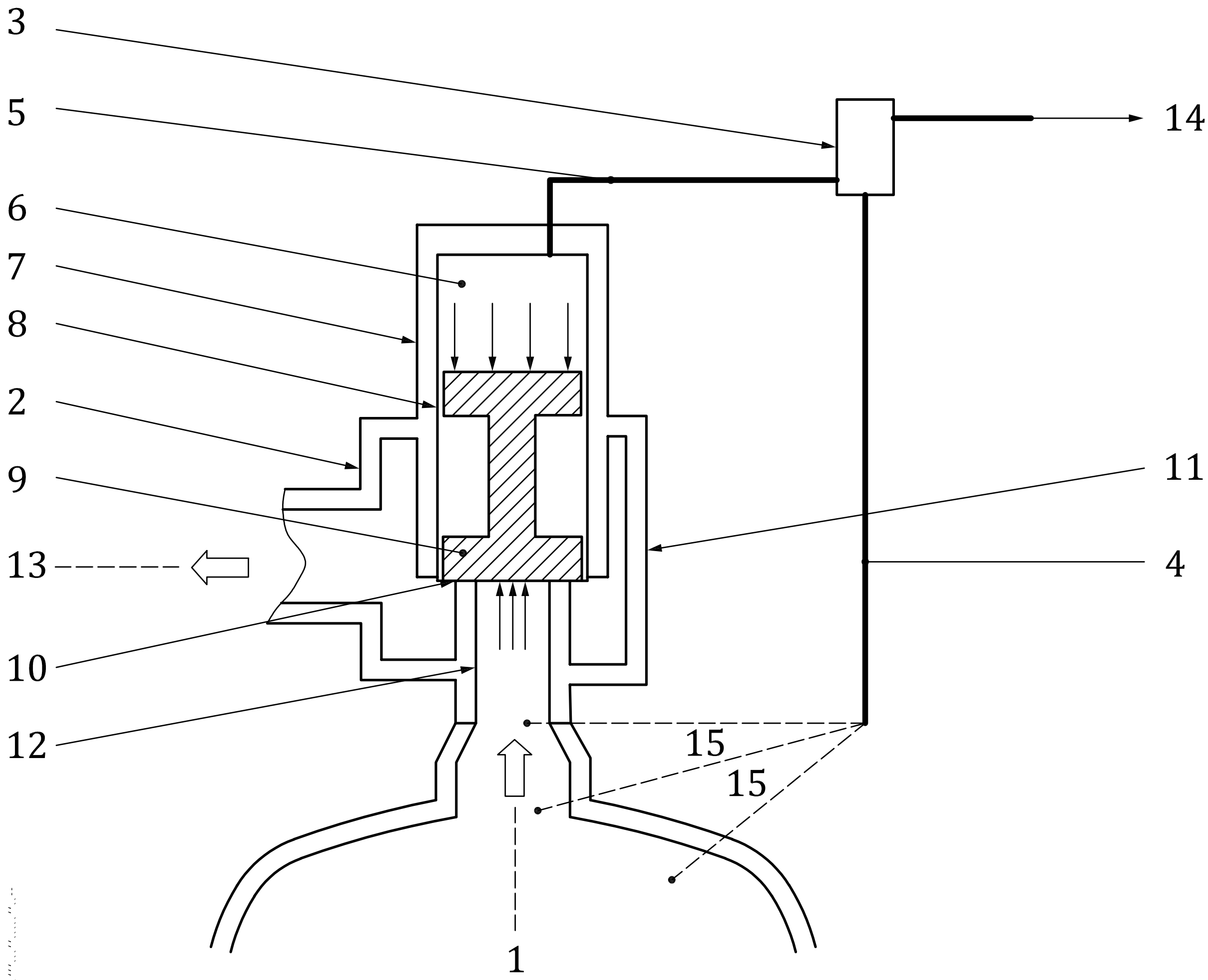
3.1
pilot operated safety valve
self-actuated device comprising a main valve and an attached pilot

Note 1 to entry: The pilot responds to the pressure of the fluid without any other actuating energy than the fluid itself and controls the operation of the main valve. The main valve opens when the fluid pressure that keeps it closed is removed or reduced. The main valve re-closes when the pressure is re-applied.

Note 2 to entry: See Figure 1 for a list of main components.

3.2
main valve
parts of a pilot operated safety valve, through which the discharge capacity is achieved

3.3
flowing pilot
pilot which discharges the fluid throughout the relieving cycle of the pilot operated safety valve



Key

1 equipment to be protected
2 main valve
3 pilot valve
4 sensing line
5 loading/unloading line
6 pressure chamber
7 cover (or cap)
8 guide
9 disc (or piston)
10 seat
11 main valve body
12 main valve inlet
13 main valve outlet
14 pilot outlet
15 connection of the sensing line (see Note)

NOTE The sensing line from the pilot can be either connected to the main valve inlet or connected directly to the equipment to be protected. In cases where the sensing line is not connected to the main valve inlet, considerations should be given to the length and to the protection from damage of the sensing line.

Figure 1 — Nomenclature of main components of a pilot operated safety valve

3.4
non-flowing pilot
pilot in which the fluid flows only during the opening and/or closing of the pilot operated safety valve

3.5
ON/OFF
action characterized by stable operation resulting in fully open or fully closed main valve position

Note 1 to entry: This is an action of the pilot operated safety valve.

3.6
modulating
action characterized by a gradual opening and closing of the disc of the main valve which is a function of the pressure, proportional but not necessarily linear

Note 1 to entry: This is an action of the pilot operated safety valve.

3.7
set pressure
predetermined pressure at which the main valve of a pilot operated safety valve under operating conditions commences to open

Note 1 to entry: It is the gauge pressure measured at the main valve inlet at which the pressure forces tending to lift the main valve disc for the specific service conditions are in equilibrium with the forces retaining the main valve disc on its seat.

3.8
maximum allowable pressure
PS
maximum pressure for which the protected equipment is designed

3.9
opening sensing pressure
pressure at which the pilot commences to open in order to achieve the set pressure

3.10
overpressure
pressure increase over the set pressure, usually expressed as a percentage of the set pressure

3.11
reseating pressure
value of the inlet static pressure at which the main valve disc re-establishes contact with the seat or at which the lift becomes zero

3.12
cold differential test pressure
inlet static pressure at which a pilot operated safety valve is set to commence to open on the test bench

Note 1 to entry: This test pressure includes corrections for service conditions, e.g. back pressure and/or temperature.

3.13
relieving pressure
pressure used for the sizing of a pilot operated safety valve which is greater than or equal to the set pressure plus overpressure

3.14
back pressure
pressure that exists at the outlet of a safety valve as a result of the pressure in the discharge system

Note 1 to entry: The back pressure is the sum of the superimposed and built-up back pressures.

3.15
built-up back pressure
pressure existing at the outlet of the main valve caused by flow through the main valve and the discharge system

3.16
superimposed back pressure
pressure existing at the outlet of the main valve at the time when the device is required to operate

Note 1 to entry: It is the result of pressure in the discharge system from other sources.

3.17
blowdown
difference between set and reseating pressures

Note 1 to entry: Blowdown is normally stated as a percentage of set pressure except for pressures of less than 3 bar when the blowdown is expressed in bar.

3.18
lift
actual travel of the main valve disc away from the closed position

3.19
flow area
minimum cross-sectional flow area (but not the smallest area between disc and seat) between inlet and seat which is used to calculate the theoretical flowing capacity of the main valve, with no deduction for any obstruction

3.20
flow diameter
diameter corresponding to the flow area

3.21
theoretical discharge capacity
calculated capacity of a theoretically perfect nozzle having a cross-sectional flow area equal to the flow area of the main valve of a pilot operated safety valve

Note 1 to entry: It is expressed in mass or volumetric units.

3.22
coefficient of discharge
value of actual flowing capacity (from tests) divided by the theoretical flowing capacity (from calculation)

3.23
certified (discharge) capacity
portion of the measured capacity permitted to be used as a basis for the application of a pilot operated safety valve

Note 1 to entry: It may, for example, equal the: a) measured flow rate times the de-rating factor; or b) theoretical flow rate times the coefficient of discharge times the de-rating factor; or c) theoretical flow rate times the certified de-rated coefficient of discharge.

3.24
DN (nominal size)
alphanumeric designation of size that is common for components used in a piping system, used for reference purposes, comprising the letters DN followed by a dimensionless number having an indirect correspondence to the physical size of the bore or outside diameter of the component end connection

Note 1 to entry: The dimensionless number does not represent a measurable value and is not used for calculation purposes.

Note 2 to entry: Prefix DN usage is applicable to components bearing PN designations according to ISO 7268.

Note 3 to entry: Adapted from ISO 6708:1995, definition 2.1.

4 Symbols and units

Table 1 — Symbols and their descriptions

Symbol	Description	Unit
A	Flow area of a safety valve (not smallest area between seat and disc)	mm^2
K_d	Coefficient of discharge[a]	—
K_{dr}	Certified de-rated coefficient of discharge (K_d × 0,9)[a]	—
n	Number of tests	—
q_m	Theoretical specific discharge capacity	$kg/(h \cdot mm^2)$
q'_m	Specific discharge capacity determined by tests	$kg/(h \cdot mm^2)$

[a] K_d and K_{dr} are expressed as 0,xxx.

5 Design

5.1 General

5.1.1 The design shall incorporate guiding arrangements necessary to ensure consistent operation and seat tightness.

5.1.2 The seat of the main valve, other than when it is an integral part of the valve shell, shall be fastened securely to prevent the seat becoming loose in service.

5.1.3 Means shall be provided to lock and/or to seal all external adjustments in such a manner so as to prevent or reveal unauthorized adjustments of the pilot operated safety valve.

5.1.4 In the case of main valves with restricted lift, the lift restricting device shall limit the main valve lift but shall not otherwise interfere with the operation of the main valve. The lift restricting device shall be designed so that, if adjustable, the adjustable feature can be mechanically locked and sealed. The lift restricting device shall be installed and sealed in accordance with the design of the manufacturer.

The valve lift shall not be restricted to a value less than 1 mm.

5.1.5 Pilot operated safety valves for toxic or flammable fluids shall have the pilot vented to a safe place.

5.1.6 The main valve shall be provided with a drain connection at the lowest point where liquid can collect unless other provisions for draining are provided.

5.1.7 The design stress of pressure-retaining shells shall not exceed that specified in the appropriate standards.

NOTE For example, EN 12516 or ANSI/ASME B 16.34 may be used as reference.

5.1.8 The materials for adjacent sliding surfaces such as guides and disc/disc holder/spindle shall be selected to ensure corrosion resistance and to minimize wear and avoid galling.

5.1.9 In the case of reasonably foreseeable damage to connections between the various components, the resulting flow areas shall be such that the pilot operated safety valve will discharge its certified capacity at not more than 1,1 times the maximum allowable pressure.

5.1.10 When the superimposed back pressure can be higher than the inlet pressure, means shall be provided so that the main valve does not open.

5.1.11 Easing gear shall be provided when specified or alternatively means for connecting and applying pressure to the pilot adequate to verify that the moving parts critical to proper operation are free to move.

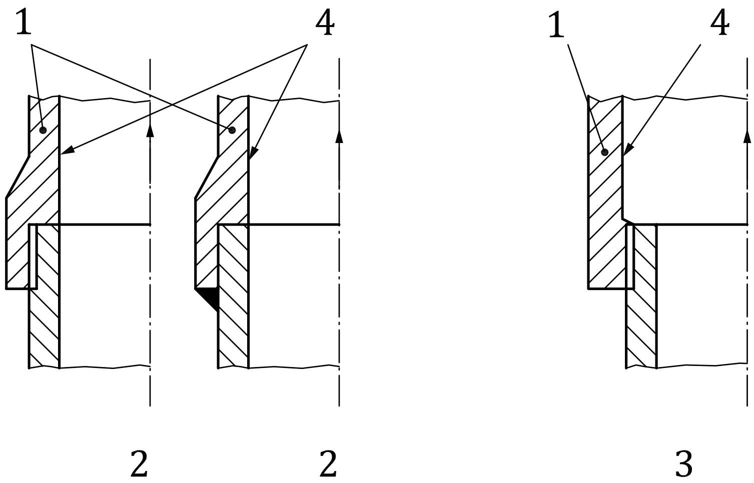
5.1.12 The fitting of any additional device to a pilot and main valve combination shall not prevent the pressurized system from being protected under any circumstances.

5.2 Valve end connections

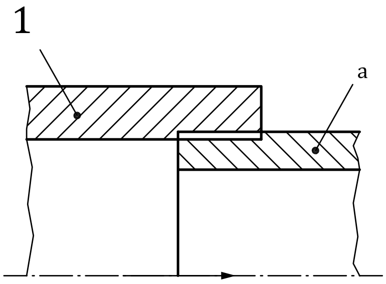
The inlet design of valve end connections, regardless of type, shall be such that the internal area of the external pipe or stub connection at the safety valve inlet is at least equal to that of the valve inlet connection [see Figure 2 a)].

The outlet design of valve end connections, regardless of type, shall be such that the internal area of the external pipe connection at the safety valve outlet is at least equal to that of the valve outlet, except those valves with female threaded outlet connections [see Figure 2 b)].

NOTE See Clause 7 regarding type testing.



a) Inlet



b) Outlet

Key

1 main valve

2 satisfactory

3 unsatisfactory

4 required internal diameter of the pilot operated safety valve for the valve to function properly

[a] If the nominal diameter of the pipe is not equal to the nominal diameter of the valve outlet as shown, then a suitable pipe shall be fitted during testing as specified in 7.1.4.

Figure 2 — Design of end connections

5.3 Minimum requirements for springs

Pressure setting springs, as applicable, shall be in accordance with ISO 4126-7.

5.4 Materials

Only approved materials shall be used for pressure retaining shells.

NOTE For example, EN 12516 or any other national or internationally recognized standards (e.g. ASME, JIS, etc.) may be used as reference.

These materials and their temperature limitations shall be suitable for pressure-containing function.

6 Production testing

6.1 Purpose

The purpose of these tests is to ensure that all pilot operated safety valves meet the requirements for which they have been designed without exhibiting any form of leakage from pressure-retaining components or joints.

6.2 General

All temporary pipes, connections and blanking devices shall be adequate to withstand the test pressure.

Any temporary welded-on attachments shall be carefully removed and the resulting weld scars shall be ground flush with the parent material. After grinding, all such scars shall be inspected by using magnetic particle or liquid penetrant techniques.

6.3 Hydrostatic testing

6.3.1 Application

The portion of the main valve shell exposed to the inlet pressure shall be tested to a pressure 1,5 times the manufacturer's stated maximum pressure for which the pilot operated safety valve is designed.

The portion of the main valve shell exposed to outlet pressure shall be tested to 1,5 times the manufacturer's stated maximum back pressure for which the valve is designed. This pressure can be lower than that given by the outlet flange rating.

6.3.2 Duration

The test pressure shall be applied and maintained at the required magnitude for a sufficient length of time to permit a visual examination to be made of all surfaces and joints, but in any case for not less than the times given in Table 2. For tests on the discharge side of the seat, the testing time shall be based on the pressure specified in 6.3.1 and the discharge size.

Table 2 — Minimum duration of hydrostatic test

Nominal size DN	**Minimum duration** in seconds
DN ≤ 50	15
65 < DN ≤ 200	60
DN ≥ 250	180

6.3.3 Acceptance criteria

No leakage from the tested parts as defined in 6.3.1 is accepted.

6.3.4 Safety requirements

Water of suitable purity shall normally be used as the test medium. Where other testing media are used, additional precautions may be necessary. Valve bodies shall be properly vented to remove entrapped air.

If materials which are liable to failure by brittle fracture are incorporated in that part of the pilot operated safety valve which is to be hydrostatically tested, then both the pilot operated safety valve, or part thereof, and the testing medium shall be at a sufficient temperature to prevent the possibility of such failure.

No valve or part thereof undergoing pressure testing shall be subjected to any form of shock loading, for example hammer testing.

6.4 Pneumatic testing

6.4.1 Application and duration of test

Pressure testing with air or other suitable gas should be avoided but may be carried out in place of the standard body hydrostatic test with the agreement of all parties involved in the following cases:

a) valves of such design and construction that it is not practicable for them to be filled with liquid; and/or

b) valves that are to be used in service where even small traces of water cannot be tolerated.

The portions of the valve to be tested, test pressure, duration of application and acceptance criteria shall be as specified in 6.3.

6.4.2 Safety requirements

The hazards involved in pneumatic pressure testing shall be considered and adequate precautions taken.

Particular attention is drawn to some relevant factors as follows.

a) If a major rupture of the valve should occur at some stage during application of pressure, considerable energy will be released; hence no personnel should be in the immediate vicinity during pressure raising (for example a given volume of air contains 200 times the amount of energy that a similar volume of water contains when both are at the same pressure).

b) The risk of brittle failure under test conditions shall have been critically assessed at the design stage and the choice of materials for valves which are to be pneumatically tested shall be such as to avoid the risk of brittle failure during test. This necessitates provision of an adequate margin between the transition temperature of all parts and the metal temperature during testing.

c) Attention is drawn to the fact that if there is a reduction in gas pressure between the high-pressure storage and the valve under test, the temperature will decrease.

Valves undergoing pneumatic test should not be approached for close inspection until after the pressure increase has been completed.

No valve undergoing pneumatic test shall be subject to any form of shock loading.

Precautions shall be taken against pressures generated in excess of test pressure.

6.5 Adjustment of set or cold differential test pressure

Each pilot operated safety valve shall be adjusted to its designated set or cold differential test pressure.

It is not permissible to adjust the set or cold differential test pressure of a pilot operated safety valve using air or other gas as the test medium unless the pressure-retaining parts have previously been subjected to a test in accordance with 6.3 or 6.4.

It is permissible to establish the set or cold differential test pressure by adjustment of the pilot only. In cases such as these, it shall be shown that the opening sensing pressure of the pilot achieves the required set pressure of the main valve.

6.6 Seat leakage test

6.6.1 General

The seat leakage test of the pilot operated safety valve shall be carried out after the adjustment of the set or the cold differential test pressure. The test procedure and the leakage rate shall be agreed between the manufacturer and the purchaser. When it is not the case, the values in 6.6.3 and 6.6.4 shall be used.

6.6.2 Test procedure

The pilot and the main valve can be tested separately. Blank off the outlet/s and using air or nitrogen gas, reduce the inlet pressure by 10 % or 0,35 bar below the value of set or cold differential test pressure, whichever is the greater. The leakage rate up to 70 bar set pressure shall not exceed the values in 6.6.3 and 6.6.4. At pressure above 70 bar the maximum leakage rate shall increase in direct proportion to the increase of set or cold differential test pressure.

When the pilot discharge is connected into the main valve outlet, the leakage rate through both the pilot and the main valve can be added together, and its measurement carried out at the main valve outlet.

Bubble leak measurement shall be carried out using 6 mm internal diameter pipe inserted 13 mm into a volume of water.

NOTE Alternatively, API 527 can be used.

6.6.3 Pilot leakage rate

The leakage rate shall not exceed:

— elastomeric seat version: 0 bubbles/min;

— metal seat version: 20 bubbles/min.

6.6.4 Main valve leakage rate

The leakage rate shall not exceed:

— elastomeric seat version: 5 bubbles/min;

— metal seat version: 20 bubbles/min.

6.7 Pressure seals

All pressure seals between valve, loading/unloading line and sensing line shall be leak tested. If appropriate, hold for 1 min at 10 % or 0,35 bar, whichever is the greater, below set pressure, using air or nitrogen. Leakage is not acceptable.

7 Type testing

7.1 General

7.1.1 Application

The operating and flow characteristics of pilot operated safety valves shall be determined by type tests in conformity with this clause.

This subclause applies to the types of devices defined in 3.1.

7.1.2 Tests

The tests to determine the operating characteristics shall be in accordance with 7.2 and the tests to determine the flow characteristics shall be in accordance with 7.3.

When these tests are carried out separately, the parts of the valve which influence fluid flow shall be complete and installed in the valve.

The testing procedure, test rig and equipment shall be such that the operability and capacity at the relieving pressure can be established.

7.1.3 Objectives of tests

The objective of the tests is to determine, under specific testing conditions as a minimum, the following characteristics of the valves before opening, while discharging and at reseating:

a) set pressure;

b) overpressure;

c) reseating pressure/blowdown;

d) reproducibility of valve performance;

e) mechanical characteristics of the valves determined by sight or hearing such as:

- ability to reseat satisfactorily;
- absence of chatter, flutter, sticking and/or harmful vibration;

f) lift at overpressure;

g) actual mass flow rate.

7.1.4 Procedure for testing

The tests shall provide suitable data from which the operational and flow characteristics may be determined. For valves with internally screwed connections on the outlet with a configuration as shown in Figure 2 b), a pipe of appropriate thickness, at least five diameters long, shall be fitted during the test.

7.1.5 Results calculated from the tests

The theoretical flowing capacity is calculated in accordance with ISO 4126-7 as applicable, and, using this value together with the actual flowing capacity at relieving pressure, the coefficient of discharge of the valve is calculated in accordance with ISO 4126-7.

7.1.6 Design changes

When changes are made in the design of a pilot operated safety valve in such a manner as to affect the flow path, lift or performance characteristics, new tests shall be carried out in accordance with this clause.

7.2 Tests to determine operating characteristics

7.2.1 General requirements

Valves for air or other gas service shall be tested using air or any other gas of known characteristics or superheated steam with a minimum of 10 °C of superheat. Valves for steam service shall be tested on steam, air or other gas of known characteristics. Valves for liquid service shall be tested on water or other liquids of known characteristics.

The allowable tolerances or limits as applicable on the operating characteristics are as follows:

a) set pressure: ± 3 % of set pressure or ± 0,1 bar, whichever is the greater.

If the pilot is to be adjusted separately from the main valve, the pressure to which the pilot is adjusted may not be the same as the set pressure. The opening sensing pressure shall be specified by the manufacturer. It shall be demonstrated that the pilot is adjusted in such a way that the above tolerance on set pressure is maintained;

b) overpressure: the value stated by the manufacturer but not exceeding 10 % of set pressure or 0,1 bar, whichever is greater;

c) lift at overpressure: not less than the value stated by the manufacturer;

d) blowdown: not greater than the value stated by the manufacturer, but within the following limits:

   — compressible fluids: minimum: 2,0 % (not applicable for the pilot operated safety valves with modulating action),

   maximum: 15 % or 0,3 bar, whichever is greater;

   — incompressible fluids: minimum: 2,5 % (not applicable for the pilot operated safety valves with modulating action),

   maximum: 20 % or 0,6 bar, whichever is greater;

e) overpressure and blowdown of restricted lift pilot operated safety valves shall have the same tolerances or limits as the unrestricted lift valves;

f) overpressure and blowdown of pilot operated safety valves with modulating action shall be verified and be stable for various lifts between the minimum and maximum stated by the manufacturer.

7.2.2 Pilot operated safety valve opening characteristics

The manufacturer shall specify the type of pilot and the type of action of the valve.

7.2.3 Test equipment

The uncertainty of pressure measurement shall be within ± 0,5 %.

7.2.4 Valves used in the test programme (pilot and main valve in combination)

The pilot operated safety valves tested shall be representative of the design, pressure and size range of valves for which operating characteristics are determined within the capability of the test laboratory.

For main valve size ranges containing seven or more sizes, tests shall be carried out on three sizes. If the size range contains not more than six sizes, the number of sizes tested may be reduced to two.

When a size range is extended so that the pilot operated safety valves tested previously are no longer representative of the range, further tests on the appropriate number of sizes shall be carried out.

The tests of the pilot and main valve as a combination shall be carried out using three significantly different pilot settings for each size of valve tested. Where three test pressures are required from one valve size, this may be achieved by testing either one valve with three different pilot settings or three valves of the same size at three significantly different pilot settings. Each test shall be carried out a minimum of three times in order to establish and confirm acceptable reproducibility of performance. Tests at the minimum design set pressure shall be carried out.

In the case of pilot operated valves of which one size only at various pressure ratings is being manufactured, tests shall be carried out using four different pilot settings which shall cover the range of pressures for which the valve is to be used.

Where the size range cannot be adequately covered then scale models of the main valve shall be used. Reduced scale models shall have a minimum valve flow diameter of 40 mm.

All dimensions of the flow path in the model shall be strictly to scale with the corresponding dimensions of the actual valve.

All dimensions of the parts that can affect the overall thrust exercised by the medium on the moving parts shall be to scale.

The roughness of all surfaces of the flow path of the model shall not be less than that of the corresponding surfaces of the actual valve.

Before tests are carried out, it shall be verified that the model conforms with the above.

7.3 Tests to determine flow characteristics

7.3.1 Test requirements

After the operating characteristics (see 7.2) have been satisfactorily established, it is acceptable to use steam, air or other gas of known characteristics as the fluid for flow characteristic tests except for valves designed for liquid service. Pilot operated safety valves for use with liquids shall be tested with water or other liquid of known characteristics. Further, when discharged quantities are being assessed, the main valve disc shall be limited to the minimum lift as determined by the operating characteristics test at the chosen overpressure, in cases where flow characteristics and operating characteristics are determined independently.

7.3.2 Valves used in the test programme

The main valve of the pilot operated safety valves tested shall be the same as, or identical to, those used for the operating characteristics tests (see 7.2.4).

7.3.3 Test procedure

7.3.3.1 Test conditions

The testing procedure, test rig and equipment shall be approved before testing is undertaken.

The testing procedure, test rig and equipment shall be such that the capacity at the overpressure can be established.

The tests can be carried out with or without the pilot.

7.3.3.2 Number of test valves

The tests shall be carried out at three different pressures for each of three sizes of a given main valve design unless the size range contains not more than six sizes, in which case the number of sizes tested may be reduced to two.

When a size range is extended from one containing less than seven sizes to one containing seven or more sizes, then tests on three sizes of valves (a total of nine tests) shall be carried out.

In the case of valves of either novel or special design of which one size only at various pressure ratings is being manufactured, tests shall be carried out at four different set pressures which shall cover the range of pressures for which the valves will be used, or as determined by the limits of the test facility.

7.3.3.3 Restricted lift valves

For restricted lift valves the capacity at restricted lift may be determined immediately following the tests to determine flow characteristics at full lift or determined later.

In the case of restricted lift designs, a curve of coefficient of discharge versus lift may be established. Tests shall be performed at minimum lift, maximum lift and at least three lifts between minimum and maximum lift using a minimum of three test pressures at each lift. This curve may be used to establish the coefficient of discharge for any lift between minimum and maximum lift.

7.3.3.4 Value of test pressure

Three tests shall be carried out on each main valve size at test pressures whereby the ratio of absolute back pressure to absolute relieving pressure is less than 0,25.

These tests shall be carried out with atmospheric back pressure.

For compressible fluids when the ratio of absolute back pressure to absolute relieving pressure exceeds the value of 0,25, the capacity of the main valve can be largely dependent upon this ratio. Then tests shall be conducted at ratios between the pressure ratio of 0,25 and the maximum pressure ratio required to obtain curves of the coefficient of discharge K_d versus the ratio of absolute back pressure to absolute relieving pressure. This curve may be extended to cover the tests with pressure ratios less than 0,25.

This curve shall be used for establishing the coefficient of discharge at any set pressure and overpressure. It shall also be used for establishing the coefficient of discharge under back pressure conditions.

7.3.3.5 Flow testing acceptance tolerance

In all the methods described for flow characteristics testing, all final results shall be within ± 5 % of the arithmetic average to certify one common discharge coefficient.

Where these tolerances are not achieved when testing, to produce the curve of the coefficient of discharge versus the ratio of absolute back pressure to absolute relieving pressure greater than 0,25, the curve illustrating the lowest coefficient of discharge versus this ratio shall be accepted for the range of main valves tested.

7.3.4 Adjustment during test

No adjustment to the main valve or pilot shall be made during the test. Following any changes or deviation in the test conditions, a sufficient period of time shall be allowed to permit the rate of flow, temperature and pressure to reach stable conditions before readings are taken.

7.3.5 Records and test results

The test records shall include all observations, measurements, instrument readings and instrument calibration records (if required) for the objective(s) of the tests. Original test records shall remain in the custody of the test establishment that conducted the tests. Copies of all test records shall be supplied to each of the parties concerned with the tests. Corrections and corrected values shall be entered separately in the test record.

The manufacturer or his authorized representative shall keep a copy of the test records and their additions for a period of 10 years after the last of the safety valves has been manufactured.

7.3.6 Flow test equipment

The test equipment shall be designed and operated such that the actual test flowing capacity measurements are accurate to within ± 2 %.

7.4 Determination of the coefficient of discharge

The coefficient of discharge K_d is calculated using Formula (1):

$$K_d = \frac{\sum_{1}^{n} \left(\frac{q'_m}{q_m} \right)}{n} \quad (1)$$

7.5 Certification of coefficient of discharge

The certified de-rated coefficient of discharge K_{dr} of the pilot operated safety valve shall be not greater than 90 % of the coefficient of discharge K_d determined by Formula (2):

$$K_{dr} = 0{,}9\, K_d \quad (2)$$

Neither the coefficient of discharge, nor the certified de-rated coefficient of discharge can be used to calculate the capacity at a relieving pressure with a lower overpressure than that at which the tests to determine the flow characteristics (see 7.3) were carried out, although they can be used to calculate the capacity at any higher relieving pressure.

8 Determination of pilot operated safety valve performance

Refer to ISO 4126-7.

9 Sizing of pilot operated safety valves

Refer to ISO 4126-7.

10 Marking and sealing

10.1 Marking

10.1.1 Marking on the shell of the main valve

Marking on the shell of the main valve may be integral with the shell or on a plate securely fixed on the shell. The following minimum information shall be marked on all main valves:

a) size designation (inlet), for example DN xxx;

b) material designation of the shell;

c) manufacturer's name or trademark;

d) an arrow showing the direction of flow where the inlet and outlet connections have the same dimensions or the same pressure rating.

10.1.2 Marking on the pilot

Marking on the pilot may be integral with the pilot or on a plate securely fixed on the pilot. The following minimum information shall be marked on the body of each pilot:

a) manufacturer's type reference;

b) set pressure in bar gauge or other internationally recognized unit;

c) identification of the various ports directly on the body;

d) serial number or alternative coding to indicate year of manufacture.

10.1.3 Marking on an identification plate attached to the main valve

The following information shall be given on an identification plate securely fixed to the main valve:

a) reference to this part of ISO 4126, i.e. ISO 4126-4:2013;

b) manufacturer's type reference;

c) certified de-rated coefficient of discharge indicating reference fluid:

"G" for gas, "S" for steam and "L" for liquid;

NOTE The designation of the fluid can be placed either before or after the certified derated coefficient of discharge, e.g. G-0,815.

d) flow area, in square millimetres or any other internationally recognized unit;

e) minimum value of the lift, in millimetres, or any other internationally recognized unit, and corresponding overpressure, expressed as, for example, a percentage of set pressure;

f) serial number or alternative coding to indicate year of manufacture.

10.2 Sealing of a pilot operated safety valve

All external adjustments shall be sealed.

Bibliography

[1] ISO 6708:1995, *Pipework components — Definition and selection of DN (nominal size)*

[2] ISO 7268, *Pipe components — Definition of nominal pressure*

[3] ANSI/ASME B 16.34, *Valves — Flanged, threaded, and welding end*

[4] API 527, *Seat tightness of pressure relief valves*

[5] EN 12516 (all parts), *Industrial valves — Shell design strength*

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