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**Safety devices for protection against  
excessive pressure —**

**Part 1:  
Safety valves**

*Dispositifs de sécurité pour protection contre les pressions excessives —  
Partie 1: Soupapes de sûreté*



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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 4126-1 was prepared by Technical Committee ISO/TC 185, *Safety devices for protection against excessive pressure*.

This third edition cancels and replaces the second edition (ISO 4126-1:2004), which has been technically revised. It also incorporates the Technical Corrigendum ISO 4126-1:2004/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<sup>1)</sup>*

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

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1) Under preparation.

# Safety devices for protection against excessive pressure —

## Part 1: Safety valves

### 1 Scope

This part of ISO 4126 specifies general requirements for safety valves irrespective of the fluid for which they are designed.

It is applicable to safety valves having a 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 is not applicable to applications of 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

##### **safety valve**

valve which automatically, without the assistance of any energy other than that of the fluid concerned, discharges a quantity of the fluid so as to prevent a predetermined safe pressure being exceeded, and which is designed to re-close and prevent further flow of fluid after normal pressure conditions of service have been restored

Note 1 to entry: The valve can be characterized either by pop action (rapid opening) or by opening in proportion (not necessarily linear) to the increase in pressure over the set pressure.

#### 3.2

##### **direct loaded safety valve**

safety valve in which the loading due to the fluid pressure underneath the valve disc is opposed only by a direct mechanical loading device such as a weight, lever and weight, or spring

#### 3.3

##### **assisted safety valve**

safety valve which, by means of a powered assistance mechanism, may additionally be lifted at a pressure lower than the set pressure and will, even in the event of failure of the assistance mechanism, comply with all the requirements for safety valves given in ISO 4126

### 3.4

#### **supplementary loaded safety valve**

safety valve which has, until the pressure at the inlet to the safety valve reaches the set pressure, an additional force which increases the sealing force

Note 1 to entry: This additional force (supplementary load), which may be provided by means of an extraneous power source, is reliably released when the pressure at the inlet of the safety valve reaches the set pressure. The amount of supplementary loading is so arranged that if such supplementary loading is not released, the safety valve will attain its certified discharge capacity at a pressure not greater than 1,1 times the maximum allowable pressure of the equipment to be protected.

Note 2 to entry: Other types of supplementary loaded safety devices are dealt with in ISO 4126-5.

### 3.5

#### **set pressure**

predetermined pressure at which a safety valve under operating conditions commences to open

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

### 3.6

#### **maximum allowable pressure**

##### **PS**

maximum pressure for which the protected equipment is designed

### 3.7

#### **overpressure**

pressure increase over the set pressure

Note 1 to entry: Overpressure is usually expressed as a percentage of the set pressure.

### 3.8

#### **reseating pressure**

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

### 3.9

#### **cold differential test pressure**

inlet static pressure at which a 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.

### 3.10

#### **relieving pressure**

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

### 3.11

#### **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.

### 3.12

#### **built-up back pressure**

pressure existing at the outlet of a safety valve caused by flow through the valve and the discharge system

### 3.13

#### **superimposed back pressure**

pressure existing at the outlet of a safety 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.

**3.14**

**balanced bellows**

device which minimizes the effect of back pressure on the set pressure and/or the operation of a safety valve

**3.15**

**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.

**3.16**

**lift**

actual travel of the valve disc away from the closed position

**3.17**

**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 flow capacity, with no deduction for any obstruction

**3.18**

**flow diameter**

diameter corresponding to the flow area

**3.19**

**theoretical discharge capacity**

calculated capacity expressed in mass or volumetric units of a theoretically perfect nozzle having a cross-sectional flow area equal to the flow area of a safety valve

**3.20**

**coefficient of discharge**

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

**3.21**

**certified (discharge) capacity**

that portion of the measured capacity permitted to be used as a basis for the application of a safety valve

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

**3.22**

**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 <sup>2</sup>         |
| $K_d$    | Coefficient of discharge <sup>a</sup>                                         | —                       |
| $K_{dr}$ | Certified de-rated coefficient of discharge ( $K_d \times 0,9$ ) <sup>a</sup> | —                       |
| $n$      | Number of tests                                                               | —                       |
| $q_m$    | Theoretical specific discharge capacity                                       | kg/(h·mm <sup>2</sup> ) |
| $q'_m$   | Specific discharge capacity determined by tests                               | kg/(h·mm <sup>2</sup> ) |

<sup>a</sup>  $K_d$  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 a safety 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** In the case of valves where the lift can be reduced to conform to the required discharge capacity, restriction of the lift shall not interfere with the operation of the valve. The lift restricting device shall be designed so that, if adjustable, the adjustable feature can be mechanically locked and access sealed. The lift restricting device shall be installed and sealed in accordance with the design of the manufacturer.

Valve lift shall not be restricted to a value less than 30 % of unrestricted lift or 1 mm, whichever is the greater.

**5.1.4** 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 safety valve.

**5.1.5** Safety valves for toxic or flammable fluids shall be of the closed bonnet type to prevent leakage to atmosphere, or if vented, it shall be disposed of in a safe place.

**5.1.6** Provision shall be made to prevent liquid collecting on the discharge side of the safety valve shell.

**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 guide(s) and disc/disc holder/spindle shall be selected to ensure corrosion resistance and to minimize wear and avoid galling.

**5.1.9** The materials for the seat and disc of safety valves shall be selected to ensure resistance to metallic bonding between these two surfaces in order to prevent an increase of set pressure, e.g. sticking or cold working.

**5.1.10** Sealing elements which may adversely affect the operating characteristics by frictional forces are not permitted.

**5.1.11** Easing gear shall be provided when specified.

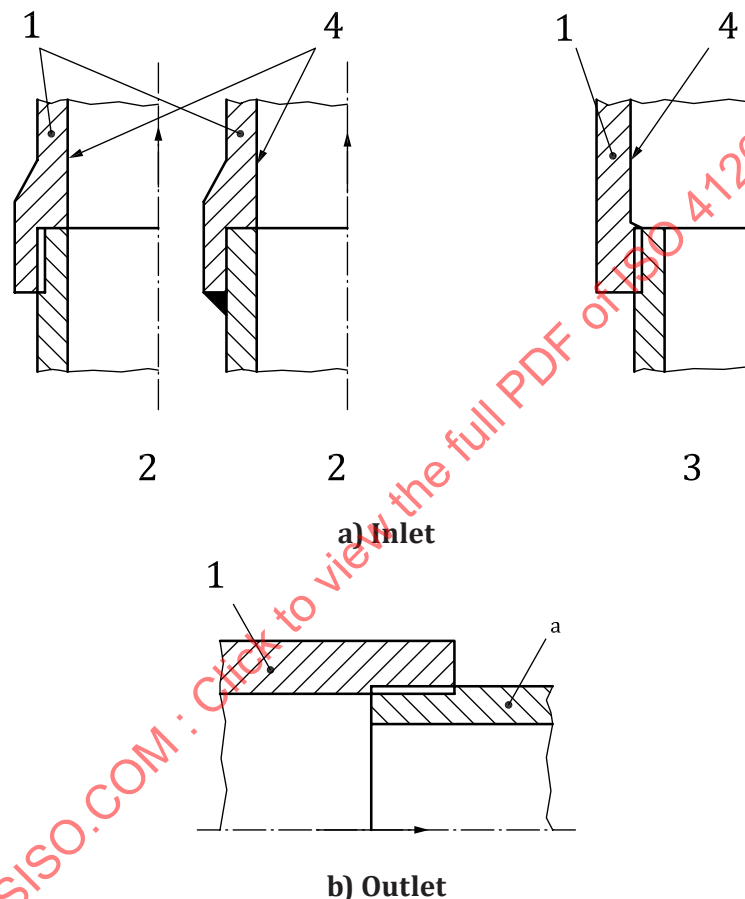
**5.1.12** Safety valves shall be constructed so that breakage of any part, or failure of any device, will not obstruct free and full discharge through the valve.

## 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 1 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 1 b](#)].

NOTE See [Clause 7](#) regarding type testing.



### Key

- |                                                                                                                                                                                                       |                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 1 valve                                                                                                                                                                                               | 3 unsatisfactory                                                                    |
| 2 satisfactory                                                                                                                                                                                        | 4 required internal diameter of the 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 <a href="#">7.1.5</a> . |                                                                                     |

**Figure 1 — Design of end connections**

## 5.3 Minimum requirements for springs

Springs 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 published national or international material standards (e.g. ASME, ASTM, 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 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

It is permissible to adopt an alternative test of equal validity (e.g. proof of design tests associated with statistical sampling) to the hydrostatic test for valve shells with:

- threaded ends; and
- a maximum inlet diameter of 32 mm; and
- a ratio of bursting pressure to design pressure of at least 8; and
- a design pressure equal to or less than 40 bar; and
- for use with non-hazardous fluids;

and also for valves as above but with:

- a design pressure greater than 40 bar; and
- a ratio of bursting pressure to design pressure of at least 10; and
- material which is either wrought or forged.

All temporary pipes and connections and blanking devices shall be adequate to safely 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 fluid penetrant techniques.

### 6.3 Hydrostatic testing

#### 6.3.1 Application

The portion of the valve from the inlet to the seat shall be tested to a pressure 1,5 times the manufacturer's stated maximum pressure for which the safety valve is designed.

The shell on the discharge side of the seat 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<br>DN    | Minimum duration<br>in seconds |
|-----------------------|--------------------------------|
| $DN \leq 50$          | 15                             |
| $65 \leq DN \leq 200$ | 60                             |
| $DN \geq 250$         | 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 liquids 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 safety valve which is to be hydrostatically tested, then both the 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 shell hydrostatic test with the agreement of all parties involved in the following cases:

- valves of such design and construction that make it not practicable for them to be filled with liquid; and/or
- 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 and duration of application 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:

- 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);
- the risk of brittle failure under test conditions shall have been critically assessed at the design stage and the choice of materials for valves that 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 safety valve shall be adjusted to its designated set or cold differential test pressure.

Before adjusting a safety valve to the set or, if applicable, cold differential test pressure using air or other gas as the test medium, it shall previously be subjected to a hydrostatic test (see 6.3).

## 6.6 Seat leakage test

The seat leakage test of a safety valve shall be carried out after adjustment of the set or cold differential test pressure. The test procedure and leakage rate shall be agreed between the manufacturer and the purchaser.

NOTE For example, API 527 can be used.

# 7 Type testing

## 7.1 General

### 7.1.1 Application

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

— This clause applies to the types of safety 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 Objective 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;

- d) reproducibility of valve performance;
- e) mechanical characteristics of the valves determined by sight or hearing such as:
  - ability to reseal 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 1 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 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 [Clause 7](#).

### 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:  $\pm 3\%$  of set pressure or  $\pm 0,1$  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 Safety valve opening characteristics

The manufacturer shall specify the lift characteristic for all safety valves.

### 7.2.3 Test equipment

The uncertainty of pressure measurement shall be within  $\pm 0,5$  %.

### 7.2.4 Valves used in the test programme

The 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. The ratio of valve inlet to flow area and the ratio of flow area to valve outlet shall be taken into account.

For 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 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 shall be carried out using three significantly different springs for each size of valve tested. This may be achieved by testing either one valve with three significantly different springs or three valves of the same size with three significantly different springs. 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 valves of which one size only at various pressure ratings is being manufactured, tests shall be carried out using four different springs, 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 shall be used having a flow-diameter not less than 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.

In the case of balanced bellows, it is permitted that the effective area be only to scale.

NOTE Effective area is the area of the balanced bellows from which end loads are calculated (piston area).

The overall spring rate of spring plus bellows, if any, of the model shall be to scale with the overall rate of the actual valve.

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. Valves for use with liquids shall be tested with water or other liquid of known characteristics. When flow characteristics are determined independently from operating characteristics, the valve disc shall be held at the lift as determined by the operating characteristics tests.

#### 7.3.2 Valves used in the test programme

The 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.

A travel stop may be fitted to limit the lift to that determined in accordance with 7.2.1 b).

The tests can be carried out with or without the spring fitted. When the spring is in the flow path, the test shall be carried out with the spring fitted.

Tests shall be conducted at various pressures to establish that no variations of the coefficient of discharge with the relevant positions(s) of the adjusting ring(s), if any, occur.

##### 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 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 fewer 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, a curve shall be established, using a minimum of three points at all test pressures, for the coefficient of discharge versus valve lift.

##### 7.3.3.4 Value of test pressure

Three tests shall be carried out on each safety 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 0,25, the coefficient of discharge 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 or tables of 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  $\pm 5\%$  of the arithmetic average to certify one common discharge coefficient.

Where these tolerances are not achieved when testing, to produce the curve of 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 valves tested.

#### 7.3.4 Adjustment during test

No adjustment to the valve shall be made during the tests. 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  $\pm 2\%$ .

### 7.4 Determination of the coefficient of discharge

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

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

### 7.5 Certification of coefficient of discharge

The certified de-rated coefficient of discharge  $K_{dr}$  of the 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 lower relieving pressure than that at which the tests to determine the flow