INTERNATIONAL STANDARD

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Second edition
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Safety devices for protection against excessive pressure —

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

Dispositifs de sécurité pour protection contre les pressions excessives —

Partie 3: Soupapes de sûreté et dispositifs de sûreté à disque de rupture en combinaison

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 185, *Safety devices for protection against excessive pressure,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 69, *Industrial valves,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 4126-3:2006), which has been technically revised.

The main changes compared to the previous edition are as follows:

— Eliminated unnecessary references and definitions throughout the document.

— Clause 5: Inlet line and pressure drop requirements from prior 6.2 were moved to Clause 5 and a reference to ISO 4126-9 was also added.

— Clause 7: Deleted specific references to specific EN standards to refer to the applicable pressure vessel standard to reflect the global nature of this document.

— Clause 9: The restrictions for F_d values less than 0,97 were eliminated.

— Clause 12: Clarified the applicable minimum bursting pressure for which the F_d value can be used for sizes larger than those flow tested.

— Clause 14: Added a requirement for the supplier to provide a test certificate if the F_d being used is a certified combination discharge coefficient.

A list of all parts in the ISO 4126 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Bursting disc safety devices can be used upstream of safety valves in the following cases:

a) to protect the safety valve against corrosion, fouling or operating conditions which could affect the safety valve performance;

b) to prevent leakage;

c) to prevent total loss of contents from the protected equipment following the bursting of the bursting disc.

The term *combination* is used to describe the close-coupled (i.e. within 5 pipe diameters) assembly of a bursting disc safety device upstream of a safety valve or controlled safety pressure relief systems (CSPRS), as defined by this document. Requirements for other installation arrangements of bursting discs with safety valves or CSPRS are defined in ISO 4126-9.

Safety devices for protection against excessive pressure —

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

1 Scope

This document specifies only the requirements for a product assembled from the in-series combination of safety valves or CSPRS (controlled safety pressure relief systems) according to ISO 4126-1, ISO 4126-4 and ISO 4126-5, and bursting disc safety devices, according to ISO 4126-2, installed upstream of the valve within five pipe diameters of the valve inlet. It specifies the design, application and marking requirements for such products, composed of the bursting disc safety device, a safety valve or CSPRS and, where applicable, a connecting pipe or spool piece. In addition, it gives a method for establishing the combination discharge factor used in sizing combinations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4126-1:2013, *Safety devices for protection against excessive pressure — Part 1: Safety valves*

ISO 4126-2:2018, *Safety devices for protection against excessive pressure — Part 2: Bursting disc safety devices*

ISO 4126-4:2013, *Safety devices for protection against excessive pressure — Part 4: Pilot operated safety valves*

ISO 4126-5:2013, *Safety devices for protection against excessive pressure — Part 5: Controlled safety pressure relief systems (CSPRS)*

ISO 4126-6:2014, *Safety devices for protection against excessive pressure — Part 6: Application, selection and installation of bursting disc safety devices*

ISO 4126-9:2008, *Safety devices for protection against excessive pressure — Part 9: Application and installation of safety devices excluding stand-alone bursting disc safety devices*

3 Terms and definitions

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

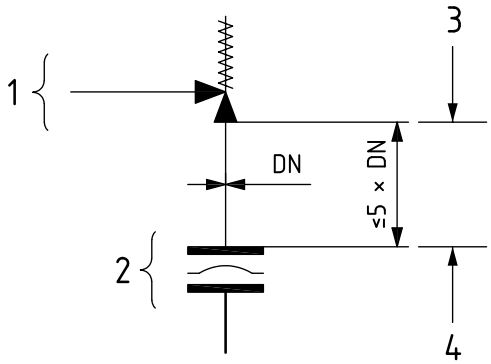
ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
combination
installation which comprises a *bursting disc safety device* (3.3) installed within five pipe diameters (from outlet of *bursting disc holder* (3.6) to inlet of valve) before the inlet of a safety valve or a CSPRS

Note 1 to entry: See Figure 1.



Key
1 safety valve or CSPRS
2 bursting disc safety device
3 safety valve or CSPRS inlet
4 bursting disc safety device outlet

NOTE Other bursting disc safety device configurations used in conjunction with safety valves or CSPRS are specified in ISO 4126-6.

Figure 1 — Diagram of combination showing relative distance

3.2
combination discharge capacity factor
F_d
factor used to determine the discharge capacity of a safety valve or CSPRS when the safety valve or CSPRS is used in combination with a *bursting disc safety device* (3.3) installed upstream of the safety valve or CSPRS

3.3
bursting disc safety device
non-reclosing pressure relief device actuated by differential pressure and designed to function by the bursting of the *bursting disc(s)* (3.5)

Note 1 to entry: It is the complete assembly of installed components including, where appropriate, the *bursting disc holder* (3.6).

3.4
bursting disc assembly
complete assembly of the components installed in the *bursting disc holder* (3.6) to perform the desired function

3.5
bursting disc
pressure-sensitive component(s) of a *bursting disc safety device* (3.3) designed to open by bursting at a *specified bursting pressure* (3.7)

3.6
bursting disc holder
part of a *bursting disc safety device* (3.3) which retains the *bursting disc assembly* (3.4) in position

3.7
specified bursting pressure
bursting pressure (3.13) quoted with a coincident temperature when defining the *bursting disc* (3.5) requirements

Note 1 to entry: It is used in conjunction with a *performance tolerance* (3.10).

3.8
specified maximum bursting pressure
maximum *bursting pressure* (3.13) quoted with the coincident temperature when defining the *bursting disc* (3.5) requirements

Note 1 to entry: It is used in conjunction with a *specified minimum bursting pressure* (3.9).

3.9
specified minimum bursting pressure
minimum *bursting pressure* (3.13) quoted with the coincident temperature when defining the *bursting disc* (3.5) requirements

Note 1 to entry: It is used in conjunction with a *specified maximum bursting pressure* (3.8).

3.10
performance tolerance
range of pressure between the *specified minimum bursting pressure* (3.9) and the *specified maximum bursting pressure* (3.8) or the range of pressure in positive and negative percentages or quantities which is related to the *specified bursting pressure* (3.7)

3.11
relieving pressure
maximum pressure under discharge conditions in the pressurised system

Note 1 to entry: It may differ from the bursting pressure of the *bursting disc* (3.5).

3.12
batch
quantity of bursting discs or *bursting disc safety devices* (3.3) made as a single group of the same type, size, materials and *specified bursting pressure* (3.7) requirements, and where the *bursting discs* (3.5) are manufactured from the same lot of material

3.13
bursting pressure
value of the differential pressure between the upstream side and the downstream side of the *bursting disc* (3.5) when it bursts

3.14
pressure relief system
system intended for the safe relief of fluids from pressure equipment for prevention of excessive pressure

Note 1 to entry: It can consist of equipment nozzle, inlet piping, pressure relief device(s) and discharge piping to atmosphere/collecting vessel/header.

3.15
certified derated coefficient of discharge
K_{dr}
adjusted *coefficient of discharge* (3.16) for the safety valve or CSPRS

Note 1 to entry: See ISO 4126-1, ISO 4126-4, or ISO 4126-5 as applicable.

3.16
coefficient of discharge
K_d
value of actual discharge capacity (from tests) divided by the theoretical discharge capacity (from calculation) of the safety valve or CSPRS.

Note 1 to entry: See ISO 4126-1, ISO 4126-4, or ISO 4126-5 as applicable.

3.17
combination coefficient of discharge
K_{dc}
tested value of actual discharge capacity of the *combination* (3.1) divided by the theoretical discharge capacity of the safety valve or CSPRS

3.18
set pressure
P_{set}
predetermined pressure at which a safety valve or CSPRS 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.

4 Symbols

A	flow area of a safety valve (not curtain area), in square millimetres
F_d	combination discharge capacity factor
K_d	coefficient of discharge of the safety valve or CSPRS
K_{dc}	combination coefficient of discharge
K_{dr}	certified derated coefficient of discharge for safety valve or CSPRS
P_{set}	set pressure of safety valve or CSPRS

5 Design of combination

Bursting disc safety devices shall comply with ISO 4126-2.

Application and selection of bursting disc safety devices shall be in accordance with ISO 4126-6.

Safety valves shall comply with ISO 4126-1 or ISO 4126-4.

CSPRS shall comply with ISO 4126-5.

Where additional components are used to combine the bursting disc safety device and the safety valve or CSPRS into a combination (e.g. spool piece), these shall comply with the applicable design standard.

The connection from the protected equipment to the safety valve inlet shall be as short as practicable and designed so that the total pressure drop to the safety valve or CSPRS inlet, including the effect of the bursting disc safety device, shall meet the requirements for the inlet line as described in ISO 4126-9. Calculate the total inlet pressure drop (difference of stagnation pressures, i.e. non-recoverable losses) using the actual flowing capacity, which is the capacity of the safety device calculated using the certified coefficient of discharge, divided by the derating factor 0,9 and multiplied by the certified combination discharge capacity factor F_d or a value of F_d = 1,0 if a certified value is not available. Please be aware of

national codes or regulations regarding the total inlet pressure drop. The pressure drop shall include the effects of isolating valves, fittings and bursting disc safety devices.

NOTE 1 This guidance is not intended to cause a redesign of existing systems that have demonstrated stable operation during valve discharge.

The space between the bursting disc safety device and the safety valve or CSPRS shall be provided with a connection to prevent or detect an unacceptable build up in pressure.

NOTE 2 Bursting discs, being pressure-differential devices, require a higher pressure in the protected equipment to burst the bursting disc if pressure builds up in the space between the bursting disc and the safety valve or the CSPRS. This occurs when leakage develops through the bursting disc due to corrosion, due to back pressure in the discharge piping or other cause.

After bursting, the bursting disc petals shall not protrude into the valve inlet unless the influence of the petals on the capacity and performance of the safety valve or CSPRS have been assessed and proven to meet the requirements of Clause 7.

The design of the bursting disc safety device shall be such that on bursting, release of bursting disc material shall not impair the performance of the safety valve or the CSPRS.

The nominal pipe size of the bursting disc safety device shall be not less than the nominal size of the inlet of the safety valve or CSPRS.

6 Installation of combination

The discharge of the combination shall be disposed of safely and be prevented from unintentional flowing into other equipment to create a hazard (for example, into equipment out of service or undergoing maintenance). The discharge pipe, between the outlet of the combination and the atmosphere or venting system, shall always be adequately drained to prevent accumulation of liquids. Provisions shall be made to absorb the reaction forces expected during the discharge of material.

The supplier of the combination shall provide assembly and installation instructions in addition to the instructions provided by the manufacturers of the bursting disc safety device and the safety valve or CSPRS, taking into consideration the results of a hazard analysis.

7 Combination performance

The pressure in the equipment to be protected shall never exceed the allowable limits.

NOTE 1 Allowable pressure limits of the equipment are governed by the applicable design standard, for example EN, JIS, ASME, API, etc.

Unless otherwise permitted by the applicable design standard, the limit of bursting pressure of the bursting disc safety device shall be defined by:

— specified minimum bursting pressure ≥0,9 P_{set};

— specified maximum bursting pressure ≤1,1 P_{set} or P_{set} + 0,1 barg (0, 01 MPa), whichever is greater.

When the combination is intended for liquid service, the bursting disc safety device and safety valve or CSPRS manufacturers shall be consulted.

NOTE 2 Special attention needs to be given to the possibility of particular circumstances (e.g. thermal relief systems or hydraulic service) that can result in a flow of media insufficient to open the safety valve, when advice from the bursting disc safety device and safety valve or CSPRS manufacturers could be necessary.

The combination shall be characterized by a combination discharge capacity factor, F_d, determined according to Clauses 8, 9 or 10 and to be applied in accordance with Clause 12.

8 Determination of combination discharge capacity factor, F_d, by testing

8.1 General

In order to determine the effect of the proximity of the burst bursting disc safety device on the coefficient of discharge of the safety valve, the manufacturer of the combination shall conduct tests to determine the combination discharge capacity factor, F_d.

Two different approaches to testing are permitted by this document: the one-size method and the three-size method (see 8.4).

The one-size method can involve testing a specific combination intended for installation in a particular application. Alternatively, by selecting the largest flow area used in that size and type of safety valve and the lowest burst pressure of the bursting disc safety device design to be used in the combination, the one-size method can be used to provide a bounding and conservative value of F_d for a limited range of parameters (e.g. one size and type of safety valve but for a limited range of flow areas).

The three-size method is normally used where series manufacture of combinations takes place and the manufacturer of the combination wishes to derive a conservative value of F_d that can be used to cover the full product range.

8.2 Test requirements

For combinations to be used for compressible fluids, tests shall be carried out using dry saturated steam, superheated steam, air or compressible fluid of other known characteristics.

NOTE Dry saturated steam in this context refers to steam with a minimum dryness fraction of 98 % or a maximum degree of superheat of 10 °C. Superheated steam in this context refers to steam with a degree of superheat greater than 10 °C.

For combination devices to be used in liquid service, tests shall be carried out using water or liquid of known characteristics.

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

The safety valve or CSPRS tested shall have the largest flow area used in that size and type of valve, except where combination discharge capacity factor, F_d, is specified for smaller flow areas.

The bursting disc safety device shall be mounted on the inlet of the safety valve or CSPRS, taking into consideration the requirements of Clause 5, if applicable.

The tests shall use the lowest burst pressure of the bursting disc safety device design that is to be used in combination with the safety valve or CSPRS design.

The certification shall apply to the combination of the same design of safety valve or CSPRS and the same design of bursting disc safety device (internal flow path of holder) as those tested, irrespective of the external bursting disc holder geometry.

The test records shall include all observations, measurements, and instrument readings and calibration records necessary to attain the objectives of the tests. Original test records shall remain in the custody of the organization responsible for the test. Copies of all test records shall be furnished to each of the parties concerned with the tests. Corrections and corrected values shall be entered separately in the test record.

8.3 Test rig

Details for the test rig(s) and test conditions, including the proposed instrumentation and calibration procedures, shall be specified before testing commences.

8.4 Test method

The following two alternative methods of testing are permitted.

a) One-size combination

   1) The combination discharge capacity factor determined by this method shall apply only to the size and type tested.

   2) For each type or model of bursting disc safety device and safety valve or CSPRS, three bursting discs of the same specified bursting pressure shall be individually burst and flow tested in accordance with 8.5.

The test results so obtained may be used as applicable in the three-size method according to 8.4 b).

b) Three-size combination

   1) Three sequential sizes of combinations shall be tested.

   2) For each of the three sizes of bursting disc safety device, three bursting discs of the same specified bursting pressure shall burst and be flow tested in accordance with 8.5. It is permissible to carry out the tests with one holder for each size of bursting disc.

8.5 Test procedure

The coefficient of discharge, K_d, of the safety valve or CSPRS used for the test shall be determined without the bursting disc safety device, in accordance with ISO 4126-1, ISO 4126-4 or ISO 4126-5, at a relieving pressure no greater than 10 % or 0,1 bar (0,01 MPa), whichever is greater, above the valve set pressure.

The bursting disc device shall then be installed at the inlet of the safety valve or the CSPRS and the bursting disc burst in accordance with the test requirements included below in order to operate the valve.

The appropriate safety precautions shall be observed when carrying out tests.

The combination shall be tested as follows.

a) With the combination installed in the test rig, the pressure at the inlet shall be increased to 90 % of the expected minimum bursting pressure in a time not less than 5 s. Thereafter, the pressure at the inlet shall be increased at a rate that allows accurate recording of the pressure until the bursting disc bursts.

b) The combination capacity test shall be performed at 10 % or a gauge pressure of 0,1 bar (0, 01 MPa), whichever is greater, above the safety valve or CSPRS set pressure duplicating the individual safety valve or CSPRS capacity test. Maintain this pressure for a period of time that permits the rate of flow, temperature and pressure to reach stable conditions before recording the test data.

c) Determine K_{dc} from the test of the combination by determining the ratio of the actual flow to the theoretical flow.

d) Repeat a), b) and c) for the remaining bursting disc safety devices of the same size.

8.6 Acceptance criteria of the tests

8.6.1 General

The results shall be approved and a combination discharge factor certified only if the following conditions are met.

8.6.2 Conditions applicable to the safety valve

The derived coefficient of discharge, K_d, of the safety valve shall be equal to or greater than the certified value of K_{dr} (see ISO 4126-1, ISO 4126-4, or ISO 4126-5 as applicable).

8.6.3 Conditions applicable to the bursting disc safety device

The bursting pressure of all bursting discs tested shall fall within the performance tolerance of the specified bursting pressure or within the maximum and minimum specified bursting pressure, whichever is marked on the bursting disc, and shall be in accordance with ISO 4126-2.

If any bursting disc does not burst in accordance with the above, the following conditions shall be satisfied.

a) If the bursting pressure of only one of the bursting discs of any one batch is not within the tolerance, two additional tests shall be performed using bursting discs from the same batch and the results from these two substituted for the rejected results.

b) If more than one of the total of the bursting discs tested of any one batch, including any substitute test [see a)], bursts at a pressure not within the tolerance, then that batch shall be rejected, and new tests of a different batch shall be conducted in accordance with 8.5.

8.6.4 Conditions applicable to combination

8.6.4.1 One-size combination

Determine the average K_{dc} for the combination as specified in 8.5 c). None of the accepted values of K_{dc} for the combination shall exceed ±5 % of the arithmetic average.

8.6.4.2 Three-size combination

Determine the average K_{dc} for each sequential size of combination as specified in 8.5 (three different-sized valves, each with three bursting discs, giving a total of 9 tests). All accepted values of K_{dc} for each type and size of combination tested shall not exceed ±5 % of the arithmetic average for that type and size. Similarly, the average K_{dc} value for the three sequential sizes of combination shall not exceed ±5 % of the arithmetic average.

8.6.4.3 Other conditions

If, for any test, the K_{dc} value of the combination falls outside ±5 % of the arithmetic averages then all test results shall be rejected, see below additional conditions.

a) If the K_{dc} of only one test under 8.6.4.2 exceeds ±5 % of the arithmetic average, two additional tests of the same size shall be performed using bursting discs from the same batch. The K_{dc} values obtained from these two tests shall be substituted for the rejected result and a new average K_{dc} shall be calculated, provided the replacement bursting discs burst at a pressure in accordance with 8.6.4.2.

b) If any of the values of K_{dc} obtained, excluding the rejected test result but including the substitute tests of 8.6.3, fall outside ±5 % of the new arithmetic average, or if the bursting pressure of one of the substitute bursting discs is not in accordance with 8.6.4.2, then all results obtained from this batch of bursting discs shall be rejected.