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Safety devices for protection against excessive pressure —

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

Dispositifs de sécurité pour la protection contre les pressions excessives —

Partie 6: Application, sélection et installation des dispositifs de sûreté à disques de rupture

Reference number
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Foreword

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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.

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ISO 4126-6 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 185, *Safety devices for protection against excessive pressure*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European Standard..." to mean "...this International Standard...".

ISO 4126-6 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*

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Foreword

This document (EN ISO 4126-6:2003) has been prepared by Technical Committee CEN/TC 69 “Industrial valves”, the secretariat of which is held by AFNOR, in collaboration with Technical Committee ISO/TC 185 “Safety devices for protection against excessive pressure”.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2004 and conflicting national standards shall be withdrawn at the latest by April 2004.

This standard for safety devices for protection against excessive pressure consists of seven parts of which this is Part 6. The various parts are :

— *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 7 contains data which is common to more than one of the parts of this standard to avoid unnecessary repetition.

Annexes A to E are informative.

This document includes a Bibliography.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

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Introduction

Safety devices for the protection of pressure equipment against excessive pressure include pressure relief devices such as safety valves and bursting disc safety devices which, dependent upon the application, may be used either as the sole pressure relieving devices or in conjunction with each other.

Operating problems frequently arise due to the use of pressure relieving devices not having been properly selected for the intended service or properly selected but whose performance is adversely affected by improper handling, wrong installation or lack of maintenance, any of which may affect the safety of the pressure equipment being protected.

It is important to consider not only the pressure relief devices but also the whole of the pressure relief system so as not to reduce the relieving capacity below that required or adversely affect the proper operation of the pressure relieving devices.

A bursting disc safety device is a non-reclosing pressure relief device which typically comprises a bursting disc, which is a pressure-containing and pressure-sensitive part designed to open by bursting at a predetermined pressure, and a bursting disc holder. There are many different types of bursting disc safety devices manufactured in corrosion resistant materials, both metallic and non-metallic, to cover a wide range of nominal sizes, burst pressures and temperatures. They are used to protect pressure equipment such as vessels, piping, gas cylinders or other enclosures from excessive pressure and/or excessive vacuum.

This standard covers the important considerations necessary in the application, selection and installation of bursting disc safety devices to give the required protection against excessive pressure and/or excessive vacuum.

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1 Scope

This standard gives guidance on the application, selection and installation of bursting disc safety devices used to protect pressure equipment from excessive pressure and/or excessive vacuum.

Annex A provides a checklist for the information to be supplied by the purchaser to the manufacturer.

Annex B gives guidance on the replacement period of a bursting disc and annex C guidance on determining the mass flow rate, for single phase fluids, of a pressure relief system that contains a bursting disc safety device

Annex E is a non-mandatory procedure for establishing the flow resistance of a burst bursting disc assembly.

The requirements for the manufacture, inspection, testing, marking, certification and packaging of bursting disc safety devices are given in Part 2 of EN ISO 4126.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN ISO 4126-1:2003, *Safety devices for protection against excessive pressure — Part 1 : Safety valves (ISO 4126-1:2003)*.

EN ISO 4126-2:2003, *Safety devices for protection against excessive pressure — Part 2 : Bursting disc safety devices (ISO 4126-2:2003).*

EN ISO 4126-4, *Safety devices for protection against excessive pressure — Part 4 : Pilot operated safety valves (ISO 4126-4:2003).*

EN ISO 4126-5, *Safety devices for protection against excessive pressure — Part 5 : Controlled safety pressure relief systems (CSPRS) (ISO 4126-5:2003)*.

EN ISO 4126-7:2003, *Safety devices for protection against excessive pressure — Part 7 : Common data (ISO 4126-7:2003)*.

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN ISO 4126-1:2003 and the following apply.

3.1
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)

NOTE It is the complete assembly of installed components, including where appropriate, the bursting disc holder.

3.2
bursting disc assembly
complete assembly of components, which are installed in the bursting disc holder to perform the desired function

3.3
bursting disc
pressure-containing and pressure-sensitive component of a bursting disc safety device

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3.4
bursting disc holder
that part of a bursting disc safety device, which retains the bursting disc assembly in position

3.5
conventional domed bursting disc (also referred to as, forward acting)
bursting disc which is domed in the direction of the bursting pressure (i.e. where the bursting pressure is applied to the concave side of the bursting disc (see Figure 1 of EN ISO 4126-2:2003)

3.6
slotted lined bursting disc
bursting disc made up of two or more layers, at least one of which is slit or slotted to control the bursting pressure of the bursting disc

3.7
reverse domed bursting disc (also referred to as, reverse acting)
bursting disc which is domed against the direction of the bursting pressure (i.e. where the bursting pressure is applied to the convex side of the bursting disc, see Figure 2 of EN ISO 4126-2:2003)

3.8
graphite bursting disc
bursting disc manufactured from graphite, impregnated graphite, flexible graphite or graphite composite and designed to burst due to bending or shearing forces

NOTE The following definitions apply :

a) **graphite** : a crystalline form of the element carbon ;

b) **impregnated graphite** : graphite in which the open porosity is impregnated with a filler material ;

c) **flexible graphite** : a graphite structure formed by the compression of thermally exfoliated graphite intercalation compounds ;

d) **graphite composite** : made up of two or more distinct materials and having different properties to those of the separate materials and in which the proportion of graphite is over 50 per cent by weight.

3.9
specified bursting pressure
bursting pressure quoted with a coincident temperature when defining the bursting disc requirements (used in conjunction with a performance tolerance, see 3.13)

3.10
specified maximum bursting pressure
maximum bursting pressure quoted with the coincident temperature when defining the bursting disc requirements (used in conjunction with specified minimum bursting pressure, see 3.11)

3.11
specified minimum bursting pressure
minimum bursting pressure quoted with the coincident temperature when defining the bursting disc requirements (used in conjunction with specified maximum bursting pressure, see 3.10)

3.12
coincident temperature
temperature of the bursting disc associated with a bursting pressure (see 3.9, 3.10 and 3.11) and which is the expected temperature of the bursting disc when it is required to burst

3.13
performance tolerance
range of pressure between the specified minimum bursting pressure and the specified maximum bursting pressure or the range of pressure in positive and negative percentages or quantities which is related to the specified bursting pressure

3.14
operating pressure
pressure existing at normal operating conditions within the system being protected

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3.15
relieving pressure
maximum pressure under discharge conditions in the pressurised system

NOTE It can differ from the bursting pressure of the bursting disc.

3.16
relieving temperature
temperature under discharge conditions in the pressurised system

NOTE It can differ from the coincident temperature specified for the bursting disc.

3.17
differential back pressure
differential pressure across a bursting disc opposed to the direction of the bursting pressure

NOTE This can be the result of pressure in the discharge system from other sources and/or a result of vacuum on the upstream side of the bursting disc.

3.18
bursting disc safety device discharge area
area which is the minimum cross-sectional flow area of the bursting disc safety device taking into consideration the possible reduction of the cross-section, e.g. by back pressure supports, catching devices or parts of the bursting disc which remain after bursting

3.19
batch
quantity of bursting discs or bursting disc safety devices made as a single group of the same type, size, materials and specified bursting pressure requirements where the bursting discs are manufactured from the same lot of material

3.20
bursting pressure
value of the differential pressure between the upstream side and the downstream side of the bursting disc when it bursts

3.21
back pressure support
component of a bursting disc safety device, which prevents damage to the bursting disc due to differential back pressure

NOTE A back pressure support, which is intended to prevent damage to the bursting disc when the system pressure falls below atmospheric pressure, is sometimes referred to as a vacuum support.

3.22
coating
layer of metallic or non-metallic material applied to components of a bursting disc safety device by a coating process

3.23
lining
additional sheet or sheets of metallic or non-metallic material forming part of a bursting disc assembly or bursting disc holder

3.24
plating
metal layer applied to a bursting disc or bursting disc holder by a plating process

3.25
temperature shield
device which protects a bursting disc from excessive temperature

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3.26
operating ratio
ratio between the operating pressure and the minimum limit of bursting pressure (see Figure 1)

NOTE 1 In the case of a pressure system with an operating pressure expressed in bar gauge and atmospheric pressure on the downstream side of the bursting disc :

$$\text{Operating ratio} = \frac{\text{operating pressure (bar)}}{\text{minimum limit of bursting pressure (bar)}}$$

NOTE 2 In the case of a pressure system with a back pressure on the downstream side of the bursting disc, the operating ratio is the value of the differential pressure between the upstream side and the downstream side of the bursting disc divided by the minimum limit of bursting pressure expressed as a differential pressure.

3.27
bursting disc safety device discharge capacity
rate at which a bursting disc safety device can discharge fluid after bursting of the bursting disc

3.28
replacement period
time period beginning at the installation of a bursting disc assembly and ending at replacement

3.29
pressure relief system
system intended for the safe relief of fluids from pressure equipment for prevention of excessive pressure

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

3.30
discharge coefficient
coefficient which determines reduction of theoretical discharge capacity of a pressure relief system by the simplified approach (see C.2) which incorporates a burst bursting disc, forming part of a bursting disc safety device

NOTE It is denoted by the symbol α.

3.31
flow resistance factor
factor which determines the resistance to flow in a pipework system caused by the presence therein of a bursting disc, forming part of a bursting disc safety device, installed in the system

NOTE It is denoted by the symbol K_R, a dimensionless factor expressed as the velocity head loss.

3.32
base pressure
pressure recorded at the pipe inlet of the bursting disc flow test system

3.33
base temperature
temperature recorded at the pipe inlet of the bursting disc flow test system

3.34
maximum allowable pressure, PS
maximum pressure for which the equipment is designed, as specified by the manufacturer

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4 Symbols and units

Table 1 — Symbols and their descriptions

Symbol	Description	Units
A_o	Required minimum cross-sectional flow area	mm^2
A_1	Cross-sectional area of upstream piping	mm^2
A_B	Bursting disc safety device discharge area	mm^2
C	Function of the isentropic exponent	-
C_{tap}	Sonic velocity at pressure tap	m/s
D	Test system pipework inside diameter	mm
f	Fanning friction for system, pipe	-
G	Mass velocity	$kg/(m^2 \cdot h)$
k	Isentropic exponent	-
K_b	Theoretical capacity correction factor for subcritical flow	-
K_v	Viscosity correction factor	-
K_R	Flow resistance factor	-
K_{tap}	Total resistance factor from pipe inlet of test system to pressure tap	-
M	Molecular mass	kg/kmol
Ma_{tap}	Mach number at pressure tap	-
Ma_1	Mach number at pipe inlet of test system	-
p_1	Test system pipe inlet pressure	bar abs.
p_B	Base pressure	bar abs.
p_b	Back pressure	bar abs.
p_c	Critical pressure	bar abs.
p_o	Relieving pressure	bar abs.
p_{tap}	Pressure at pressure tap	bar abs.
p_r	Reduced pressure	bar abs.
Q_m	Mass flow rate	kg/h
R	Universal gas constant	8314 J/mol/K
R_e	Reynolds Number	-
T_B	Base temperature	K
T_o	Relieving temperature	K
T_{tap}	Temperature recorded at pressure tap	K
T_1	Test system pipe inlet temperature	K
v_o	Specific volume at actual relieving pressure and temperature	m^3/kg
v_{tap}	Specific volume at pressure tap	m^3/kg
x [a]	Dryness of wet steam	-
Y_{tap}	Expansion factor at pressure tap	-
Y_1	Expansion factor at pipe inlet of test system	-
Z_o	Compressibility factor at actual relieving pressure and temperature	-
ρ	Density	kg/m^3
μ	Dynamic viscosity	Pa·s
Δp	Differential pressure on venting across bursting disc safety device	bar abs.
α	Discharge coefficient (see C.2.)	-

[a] x is expressed as 0,xx.

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5 Application

5.1 Subject to the requirements of the relevant standard covering the equipment to be protected, bursting disc safety devices may be used either as the sole pressure relieving device, in conjunction with safety valves or as part of a combination device.

5.2 The discharge capacity of a system including a bursting disc safety device and its maximum limit of bursting pressure (see Figure 1) at the coincident temperature shall be such that the maximum relieving pressure does not exceed the requirements of the protected equipment. Annexes C, D and E give methods for determining discharge capacity of pressure relief systems incorporating bursting disc safety devices.

5.3 The use of a bursting disc safety device as the sole pressure relieving device may be preferred in the following cases where :

a) the rate of increase in pressure may be such that the rate of response of a safety valve would make it unsuitable ;

b) leakage of the fluid cannot be tolerated under operating conditions ;

c) operating conditions may involve deposition, which would make a safety valve inoperative ;

d) the effect of low temperature would prevent a safety valve from operating ;

e) large discharge areas are required.

NOTE A bursting disc safety device is a non-reclosing pressure relieving device, which after bursting could result in the total loss of pressure/contents from the protected equipment.

For all applications the pressure relief system shall be such that following the bursting of the bursting disc assembly any fragmentation or release of material does not :

a) cause an unacceptable flow restriction within the pressure relief system ;

b) impair the proper functioning of any other safety device ;

c) affect the certified (discharge) capacity of any other safety device.

5.4 Bursting disc safety devices may be used in association with pilot operated safety valves or CSPRS (according to EN ISO 4126-4 and EN ISO 4126-5 respectively) as permitted by the relevant standard. The application of the bursting disc safety devices shall not result in excessive pressure in the protected equipment.

5.4.1 Bursting disc safety devices in conjunction with safety valve(s) may be used in the following cases :

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

b) in series, to prevent leakage ;

c) in series, to prevent total loss of contents from the protected equipment following the bursting of the bursting disc ;

d) in parallel, as an additional safeguard.

5.4.2 Where a bursting disc safety device is to be installed upstream of a safety valve the following requirements shall be met :

a) the specified bursting requirements of the bursting disc safety device shall comply with the relevant requirements of the protected equipment ;

b) for those applications where the bursting disc safety device forms part of a combination device, the requirements shall comply with the standard(s) applicable to such devices;

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c) the space between the bursting disc and the safety valve shall be provided with a means for preventing unacceptable build up in pressure.

NOTE Bursting discs, being pressure differential devices, will 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 which will occur should leakage develop in the bursting disc due to corrosion, or due to back pressure in the discharge piping or other cause.

5.4.3 Where a bursting disc safety device is to be installed downstream of the safety valve, the following requirements shall be met :

a) the bursting disc safety device and discharge piping shall be so designed as not to impair the operating characteristics of the safety valve ;

b) the space between the bursting disc and the safety valve shall be provided with a means for preventing unacceptable build up in pressure ;

NOTE A spring-loaded safety valve, which is not balanced, cannot open at its set pressure if back pressure builds up in the space between the safety valve and the bursting disc safety device. A particular design of safety valve can be required.

c) the maximum limit of bursting pressure of the bursting disc at the coincident temperature plus any pressure in the discharge piping shall not exceed the :

1) back pressure limitations of the safety valve ;

2) design pressure of any pipe or fitting between the safety valve and the bursting disc safety device ;

3) pressure permitted by the relevant standard.

5.4.4 A bursting disc safety device may be installed both upstream and downstream of a safety valve provided that the requirements of 5.4.2 and 5.4.3 are met.

5.4.5 A bursting disc safety device fitted in parallel with a safety valve as an additional safeguard (e.g. to protect equipment against the consequence of a rapid rise in pressure) shall be specified to burst at a pressure not exceeding the relevant requirements of the protected equipment.

5.4.6 Where a bursting disc safety device is fitted in series with a second bursting disc safety device, the following requirements shall be met :

a) a space between the two bursting discs shall be large enough to ensure the correct functioning of the bursting discs ;

b) the space between the bursting disc shall be provided with a means for preventing unacceptable build up in pressure.

NOTE Bursting discs, being pressure differential devices, will require a higher pressure in the protected equipment to burst the bursting disc if pressure builds up in the space between the bursting discs which will occur should leakage develop in the bursting disc due to corrosion or other causes.

6 Selection

6.1 Selection of bursting disc safety devices

6.1.1 The manufacturer's advice should be sought when selecting a bursting disc safety device for a particular application.

6.1.2 Bursting disc safety devices are differential pressure devices and therefore the pressure on both the upstream and the downstream side of the bursting disc shall be taken into consideration.

6.1.3 Consideration needs to be given to the replacement period of the bursting disc assembly. This period depends upon the type and material of the bursting disc assembly, operating conditions and many other factors.

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Guidelines for determining the replacement period of a bursting disc are given in annex B.

6.1.4 Bursting disc safety devices are frequently required to work in corrosive environments where corrosion may cause premature failure of the bursting disc. Materials likely to be affected by corrosion may be protected by coating, plating or lining which shall be supplied only by the manufacturer.

6.1.5 Selection of the appropriate bursting disc material depends upon the chemical and physical conditions that will exist on both the upstream side and the downstream side of the bursting disc safety device when it is in service.

6.1.6 Where there is the possibility of deposition of sublimates or other solids on the upstream side of the bursting disc safety device, consideration shall be given to selecting a type of bursting disc safety device suitable for such conditions.

6.1.7 When selecting the size of bursting disc safety devices, the inclusion of any back pressure support shall be taken into account when determining the minimum cross-sectional flow area.

6.1.8 The bursting pressure of a bursting disc according to its material and type may vary with its temperature.

NOTE Data regarding the expected variation of bursting pressure according to the temperature for a batch of bursting discs should be requested from the manufacturer. Generally, in the temperature range 15 °C to 30 °C inclusive, there is no significant variation in the bursting pressure. However, below or above this range a bursting disc may have respectively a lower or higher bursting pressure than that within the range. When a bursting disc safety device is specified with a bursting pressure at a coincident temperature to protect equipment, the bursting disc may not give the necessary protection with regard to the bursting pressure of the bursting disc over the whole temperature range of the protected equipment. The coincident temperature may not be the same as the temperature of the fluid.

The coincident temperature may be determined by the direct measurement or by the calculation using established heat transfer methods.

6.1.9 Bursting discs can be protected from excessive temperature by suitable location, temperature shields or other means. When it is necessary to protect a bursting disc from excessive temperature, the influence of the protection can be considered when establishing the coincident temperature.

Temperature shields cannot be used to protect a bursting disc unless recommended by the manufacturer.

6.1.10 The type of bursting disc holder and its inlet and outlet connections shall be appropriate to the method of installing the bursting disc safety device and the requirements for the safe discharge of the fluid.

6.1.11 Where a bursting disc safety device is to be installed upstream of a safety valve, so as to form a combination device, the selection shall take into consideration the requirements of the standard(s) applicable to such devices.

6.1.12 Where a bursting disc safety device is to be selected for installation upstream and/or downstream of a safety valve, both the bursting disc safety device manufacturer and the safety valve manufacturer shall be consulted. In the case of downstream application the effects on the set pressure of the safety valve due to potential leakage across the safety valve seat and/or from the downstream side of the bursting disc safety device need to be considered.

6.2 Selection of the performance tolerance

The performance tolerance is dependent upon a number of factors, including the following :

a) type of bursting disc ;

b) material of the bursting disc ;

c) method of manufacture.

In selecting the performance tolerance for a particular application, consideration shall be given to the above factors and the process conditions. The performance tolerance shall be specified by the manufacturer after consultation

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with the purchaser using one of the two alternative methods according to clause 12 of EN ISO 4126-2:2003. Typical performance tolerances are given in Table 2.

The maximum bursting pressure at the coincident temperature shall never exceed 1,1 times PS and provisions shall be made to ensure that the operating pressure will not permanently exceed PS.

The minimum limit of bursting pressure shall be selected to ensure that there is a suitable margin between it and the operating pressure. Due consideration shall be given to the operating ratio appropriate to the material and type of bursting disc and the process conditions. Typical maximum operating ratios are given in Table 3.

Table 2 — Typical performance tolerances

Types of bursting disc (see clause 5 of EN ISO 4126-2:2003)	Specified bursting pressure (bar gauge)	Typical performance tolerance
Conventional simple domed Conventional slotted domed Conventional scored simple domed	Below 0,5	± 50 %
	0,5 to below 1,5	± 30 % to ± 15 %
	1,5 and above	± 10 %
Conventional simple domed with knife blades	Below 2,0	± 0,1 bar
	2,0 and above	± 5 %
Reverse domed scored	Below 3	± 0,15 bar
	3 and above	± 5 %
Reverse domed having slip or tear-away design	Below 1	± 15 %
	1 to below 2	± 10 %
	2 and above	± 5 %
Reverse domed with knife blades	Below 1	± 0,15 bar
	1 to below 3	± 15 %
	3 and above	± 5 %
Reverse domed that functions by shearing	Below 3	± 0,15 bar
	3 and above	± 5 %
Reverse domed composite or multi-layered	Below 0,5	± 15 %
	0,5 to below 3	± 10 %
	3 and above	± 5 %
Graphite replaceable element Graphite monobloc	Below 0,5	Up to ± 25 %
	0,5 and above	± 10 %
Flat slotted lined	Below 0,5	± 50 %
	0,5 to below 1,5	± 30 % to ± 15 %
	1,5 and above	± 10 %

NOTE 1 The table gives guidance to typical performance tolerances. Closer tolerances can be achieved.

NOTE 2 The typical performance tolerances as shown are specified bursting pressure with equal positive and negative percentages or quantities. These can be converted to specified maximum bursting pressure and specified minimum bursting pressure.

NOTE 3 For each application the performance tolerance should be obtained from the manufacturer.

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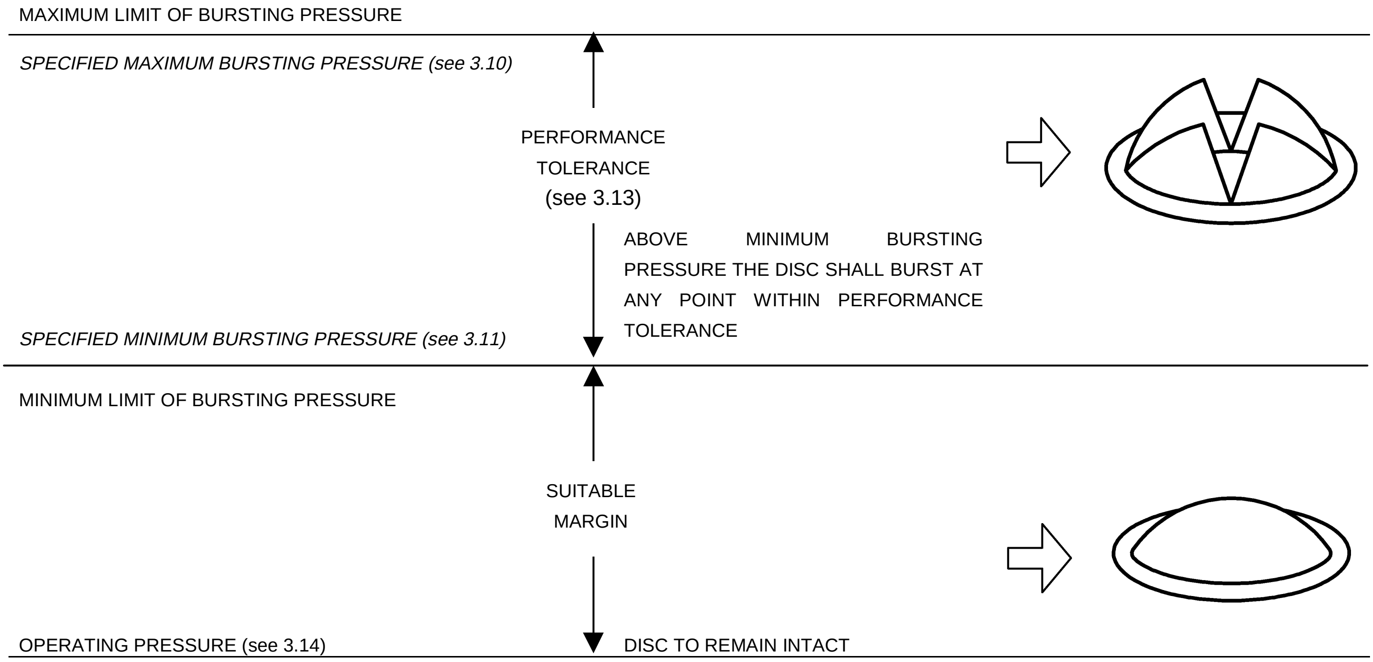

Figure 1a — Specified maximum bursting pressure and specified minimum bursting pressure with a coincident temperature

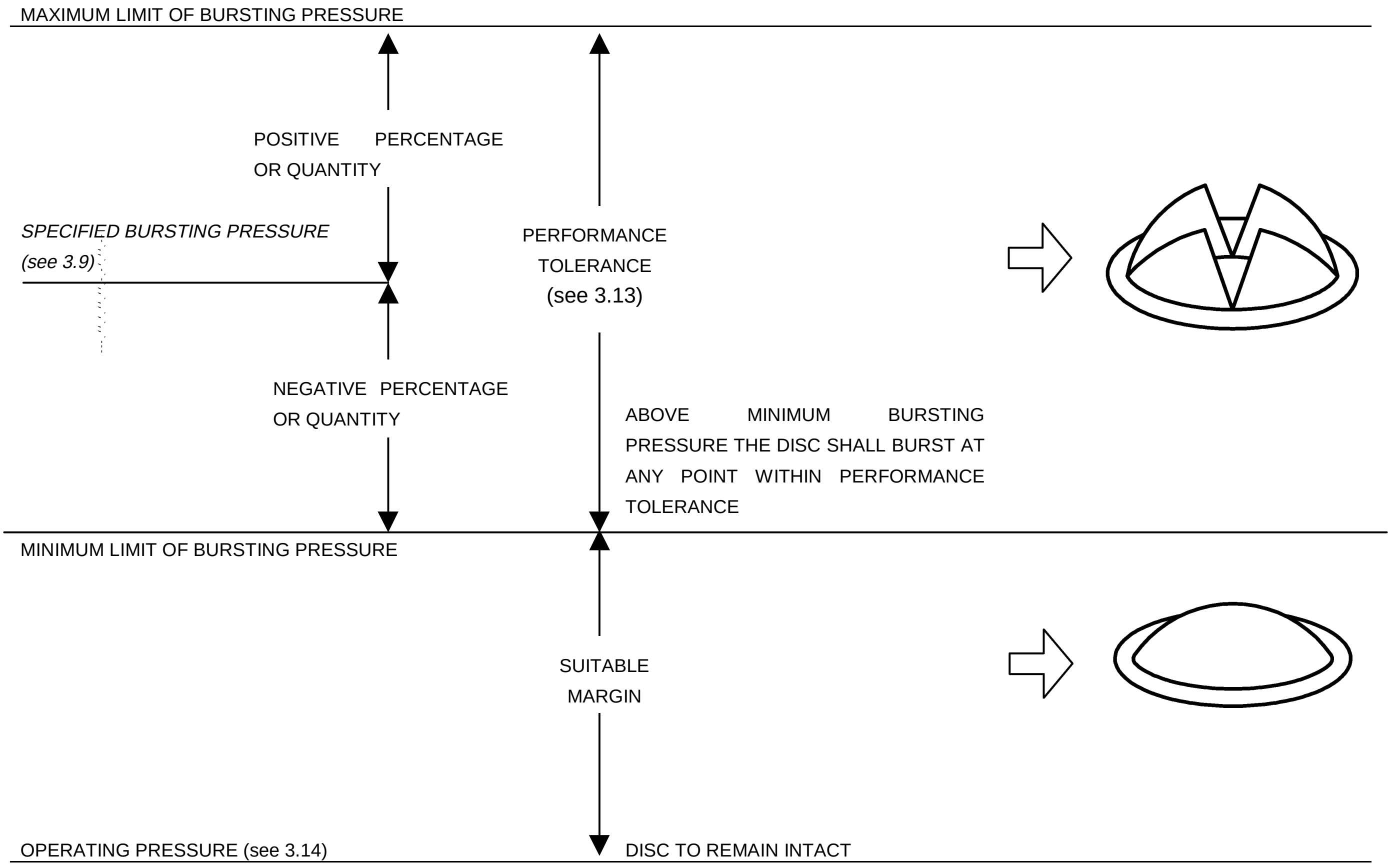

Figure 1 b — Specified bursting pressure and performance tolerance with a coincident temperature

Figure 1 — Methods for specifying bursting discs

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Table 3 — Typical maximum operating ratios

Types of bursting disc (see clause 5 of EN ISO 4126-2:2003)	Typical maximum operating ratios
Conventional simple domed	0,7
Conventional slotted domed	0,8
Conventional scored simple domed	0,8
Conventional simple domed with knife blades	0,7
Reverse domed scored	0,9
Reverse domed having slip or tear away design	0,9
Reverse domed with knife blades	0,9
Reverse domed that functions by shearing	0,9
Reverse domed composite or multi-layered	0,9
Graphite replaceable element	0,8
Graphite monobloc	0,8
Flat slotted lined	0,5

NOTE 1 For the definition of operating ratio, see 3.26.

NOTE 2 The table gives guidance as to typical maximum operating ratios for a temperature in the range 15 °C to 30 °C.

NOTE 3 The operating ratio is dependent upon a number of factors including bursting disc material, temperature and pressure cycling or pulsations, which need to be considered in order to achieve an acceptable replacement period (see annex B).

NOTE 4 For each application the operating ratio should be obtained from the manufacturer.

7 Installation

7.1 General

The requirements for the location of bursting disc safety devices within the system which they protect, are specified in 7.2. General requirements for the safe installation of bursting disc safety devices are given in 7.3.

7.2 Location of bursting disc safety devices

7.2.1 A bursting disc safety device shall be placed as close as practicable to the protected equipment, taking into account pressure pulsations, temperature, and other service conditions.

7.2.2 The pressure relief system shall be properly sized, as straight and as short as practicable, terminating in such a way as to avoid dangerous or damaging conditions arising on venting.

7.2.3 The pressure relief system piping shall be properly designed, so that any thermal movement of the protected equipment and the pressure relief system piping does not cause excessive forces on the bursting disc safety device that may lead to incorrect functioning or failure.

7.2.4 Bursting disc safety devices shall be mounted so that they are accessible for replacement and protected from accidental damage.

7.2.5 Provision shall be made to absorb the effect of reaction forces on the protected equipment, which will arise during relieving conditions.

A baffle plate may be fitted downstream of a bursting disc safety device to redirect the discharge fluid and/or reduce recoil providing that it does not reduce the required discharge capacity of the pressure relief system.

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7.2.6 In the case of the discharge of a hazardous fluid, the potential danger shall be considered and appropriate measures taken to minimize the hazard.

7.2.7 Precautions shall be taken to prevent deposition on the upstream side of the bursting disc safety device and in the part leading to it, of sublimates or other solids that could affect the safe operation of the bursting disc.

Liquid or foreign matter shall be prevented from accumulating within the discharge piping and/or on the downstream side of the bursting disc.

7.2.8 In the case of graphite monobloc bursting discs which are recessed on the inlet side (see Figure 4 of EN ISO 4126-2:2003) the internal diameter of the discharge pipe adjacent to the downstream side of the bursting disc shall be larger than the inside diameter of the recess.

7.2.9 Where plug/screw bursting disc holders are to be installed in a pressure relief system, an additional connection may be required to facilitate the assembly and replacement of the bursting disc assembly.

7.3 Installation of bursting disc safety devices

7.3.1 The bursting disc safety device shall be assembled and installed in accordance with the manufacturer's assembly and installation instructions.

NOTE If the components of a bursting disc safety device are handled, assembled or installed incorrectly, the bursting disc can burst at a pressure higher or lower than the required burst pressure.

7.3.2 The bursting disc safety device or any of its components as supplied shall not be modified in any way except with the approval of the manufacturer.

The application of an additional protective film or coating to a bursting disc is not allowed, except when approved by the manufacturer since this may considerably affect the bursting pressure of the bursting disc.

7.3.3 The bursting disc safety device shall be checked for freedom from visible defects immediately before installation and care taken during installation to avoid damage.

7.3.4 Prior to assembly, the bursting disc holder reference, marked on the bursting disc/bursting disc assembly, shall be checked to ensure that it coincides with that marked on the bursting disc holder.

7.3.5 When assembling the bursting disc safety device components the fitting of any back pressure support shall be checked to ensure that it is correct.

7.3.6 Any directional arrow, bolting torque instructions and reference to the use of gaskets shall be complied with during installation.

7.3.7 The type, material and dimensions of the gaskets used between the bursting disc safety device and the flanges between which it is to be installed shall be suitable for the specified conditions and compatible with the flange facing and finish of the contact faces of the bursting disc safety device and the flanges. The manufacturer's advice should be sought concerning the effect on the performance of the bursting disc safety device of the bolt load required to seat the gasket and maintain a seal under the specified conditions.

7.3.8 To ensure the correct performance of the bursting disc safety device and the effective sealing of the gasket used between the bursting disc safety device and the flanges between which it is installed, the bursting disc safety device shall be located centrally within the flanges.

7.3.9 Where identification marks are not visible when the bursting disc/bursting disc safety device is installed on the protected equipment, the purchaser shall be responsible for attaching to the installation a suitable tag which shall be permanently marked with the same information as that given on the bursting disc/bursting disc safety device or in the package.

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Annex A
(informative)

Information to be supplied by the purchaser

A.1 General

To assist the manufacturer in specifying a suitable bursting disc safety device for a particular application, each enquiry or order should include the information given in A.2 to A.6.

For repeat orders of replacement bursting discs, only the information given in A.7 should be provided.

A.2 Application details

a) Description of the vessel, equipment or system to be protected and vessel design code where appropriate.

b) Intended application of the bursting disc safety device. It should be stated if the device is required to operate for example as the primary relief device, secondary relief device, for safety valve protection or in some other capacity.

c) Performance specification and relative position of any safety valves or other safety devices fitted to the vessel, equipment or system.

d) The fluid which may come in contact with any part of the bursting disc safety device ; physical properties of the fluid, e.g. gas, vapour, liquid or solid ; wet or dry, at all stages of the process (including venting) ; chemical properties of the fluid which may affect bursting disc performance.

e) All conditions of temperature (including that of the bursting disc under normal operating conditions) and pressure (including back pressure) to which the bursting disc safety device may be subjected. Rate and frequency of pressure changes, if applicable.

f) Expected relieving pressure and relieving temperature (see 3.15 and 3.16).

A.3 Bursting disc safety device operating details

a) The specified bursting pressure and coincident temperature requirements (see Figure 1), stating units.

b) Rate of pressure change to bursting pressure, where appropriate.

c) Minimum bursting disc safety device discharge area required.

d) Materials which the purchaser from knowledge of the process regards as suitable for consideration in the selection of the bursting disc safety device material(s).

e) Materials which may not be used for safety, corrosion or other reasons.

A.4 Installation details

a) Physical location of the bursting disc safety device in the system, preferably in the form of a sketch.

b) Method of fitting the bursting disc safety device in the system (e.g. between flanges, direct fitting to one flange, direct weld to outlet).

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c) Inlet pipe diameter to the bursting disc safety device and discharge pipe diameter from the bursting disc safety device, including flange size, rating, type and specification or other fixing details (e.g. thread specification and size).

d) The type, material and dimensions of the gaskets to be used between the installation flanges and the bursting disc safety device.

e) Type and preferred material of the bursting disc holder (see 7.3.4).

f) Form and finish of the external mating surfaces if required other than to the manufacturer's standard.

A.5 Special details

a) Inspection and certification requirements additional to those defined in this standard.

b) Special features required in the bursting disc safety device (e.g. excess flow valve, pressure monitoring device, jacking bolts, lifting rings, baffle plate).

c) Special features of the application not stated elsewhere.

d) Leak testing requirements.

e) Non-destructive examination requirements.

A.6 Language

The language to be used for the marking and instructions should be stated.

A.7 Replacement bursting discs

a) Quantity.

b) Manufacturer's model/type reference.

c) Manufacturer's previous batch reference.

d) Nominal size designation.

e) The specified maximum bursting pressure and specified minimum bursting pressure with a coincident temperature, stating units ; or

The specified bursting pressure and related positive and negative percentages or quantities with a coincident temperature, stating units.

f) Bursting disc holder reference.

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Annex B
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Guidelines for determining the replacement period of a bursting disc

NOTE Throughout this annex the term bursting disc includes, where appropriate, bursting disc assembly and integral disc safety device.

B.1 Introduction

It is fundamental to the safety of pressure equipment that any associated pressure relief device/pressure relief system is capable of protecting the equipment from excessive pressure. In order to achieve this it is important for the continuing safe use when in service, to ensure that this capability is maintained.

Under service conditions, the pressure relief device/pressure relief system can be affected such that the original performance is no longer maintained. This can be caused by, for example, corrosion, fouling and/or other service conditions. It can also depend on the design of the pressure relief devices, their materials of construction, the service conditions and the environment to which they are subjected.

It is therefore important to establish the interval between the inspections of the pressure relief device/pressure relief system or the replacement period. In some cases, the interval between inspection will be subject to regulatory requirement. Bursting disc safety devices, dependent upon the application, can require special consideration (see B.2).

B.2 Bursting disc safety devices

Following completion of the manufacture of a batch of bursting discs a specified number are selected at random from each batch and subjected to burst testing in order to verify that the bursting pressures are in accordance with the specified requirements (see EN ISO 4126-2).

When put into service and subjected to the service conditions the characteristics of the bursting disc can change until, after a period of time, the bursting disc will no longer function within the specified requirements and may burst under normal operating pressure. For some applications, it can be necessary to determine the likely period of time for this to take place and to establish a replacement period.

The factors that may influence the replacement period are given in B.3 and various methods of establishing the replacement period are given in B.4.

B.3 Replacement period

The replacement period of a bursting disc should not exceed the predicted period of time after which the bursting disc will no longer function within the specified requirements. Once established the replacement period should not be exceeded without further consideration of past experience and all conditions of use.

There can be applications where it is safe to leave the bursting disc in service until it bursts under normal operating pressure.

An appropriate replacement period should be established before a bursting disc is put into service. This can be increased based on satisfactory operating experience or decreased where experience has proved unsatisfactory.

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In establishing the replacement period the influence of a number of factors needs to be considered, including the following :

a) type of bursting disc ;

b) materials of construction ;

c) operating ratio (see 3.26) ;

d) coincident temperature of the bursting disc ;

e) service conditions to which the bursting disc is subjected.

It is particularly important that the coincident temperature, operating criteria and foreseeable conditions, including pressure and/or temperature cycling are identified by the purchaser and specified to the manufacturer.

Where corrosion, fouling and other service conditions are not known and cannot be predicted with a degree of accuracy the initial replacement period should be such as not to compromise safety.

Of importance is correct handling and installation. Poor installation, incorrect torquing (where relevant) and mechanical damage can have an immediate effect upon the replacement period.

B.4 Methods of determining the replacement period

B.4.1 General

Methods of determining the replacement period for a bursting disc include those given in B.4.2 to B.4.5. It can be appropriate to combine methods, e.g. B.4.2 with B.4.3.

B.4.2 Use of manufacturer's data

Manufacturers are familiar with mechanical loadings, stress levels and operating ratios under different operating conditions and the limitations of their particular designs and materials. They can have data including analytical and test (cyclic, corrosion) and historical records, which can be used.

B.4.3 Use of purchaser's records

The purchaser can be familiar with the use of the particular type and material of bursting disc under comparable service conditions and can have records (operating, inspection, monitoring and historical) which can be used.

B.4.4 Testing of bursting discs after a period of service

After a period of service the bursting disc is carefully removed, properly packaged and returned to the manufacturer for examination and testing.

Dimensional changes, evidence of corrosion, leak-tightness (where appropriate), bursting pressure and any other pertinent details are recorded. By comparison with the original records for the bursting disc, adjustments can be made to the replacement period.

B.4.5 Testing under simulated conditions

A number of bursting discs of the same type, model, size, material and specified bursting requirements as those to be used are tested under conditions which simulate those expected in service. Changes in characteristics over a period of time or the period of time ending in the bursting of the bursting disc are recorded and the data used to establish the replacement period.

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Annex C
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Pressure relief system discharge capacity

C.1 General

C.1.1 The discharge capacity of the pressure relief system should be such as to ensure that under relieving conditions the maximum allowable pressure of the protected equipment is not exceeded by more than the permitted accumulation.

C.1.2 This annex gives guidance on the determination of the mass flow rate of a pressure relief system that contains a bursting disc safety device. It relates to single phase flow.

NOTE 1 Alternative methods are available to determine the discharge capacity of a pressure relief system, which are being considered for inclusion in a future version of this standard.

NOTE 2 Rules for sizing where two-phase vapour-liquid flow occurs, either because it is two-phase at the inlet or because some or all of the liquid flashed to vapour on venting, are being considered for inclusion in a future revision of this standard.

C.1.3 Two methods are given :

a) C.2 gives a simplified approach, neglecting pressure drops in the inlet piping and in the discharge piping. Therefore, this method is of limited application ;

b) C.3 gives a comprehensive approach for calculation of pressure relief systems where consideration is given to the changes in pressure throughout the entire pressure relief system.

C.1.4 It is important to ensure that the method selected is relevant to the particular application and is correctly applied by those appropriately qualified and experienced.

C.2 Simplified approach

C.2.1 General

This method should be used where it can be safely assumed that there are only negligible pressure drops in the inlet piping and the discharge piping and is limited to those applications where :

— the bursting disc safety device discharges directly to atmosphere ;

— and the bursting disc safety device is installed within eight pipe diameters from the entry to the equipment nozzle ;

— and the bursting disc safety device discharge area is not less than 50 % of the inlet pipe area ;

— and the nozzle configurations are as given in Table C.1 ;

— and the flow is single phase ;

— and the length of the discharge pipe following the bursting disc safety device does not exceed five pipe diameters ;

— and the nominal pipe diameter of the inlet and discharge piping are equal to, or greater than the nominal size of the bursting disc safety device.

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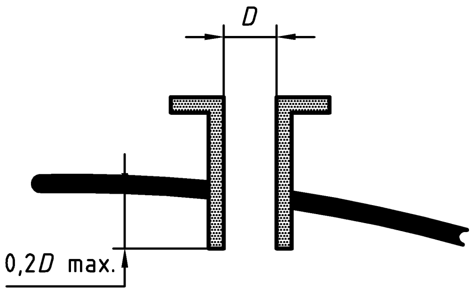
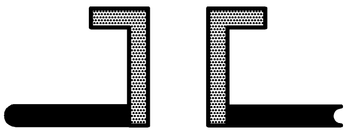
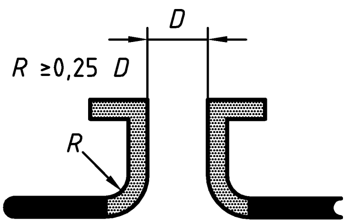
C.2.2 Compressible fluids

C.2.2.1 General

In this case, the flow rate is controlled by the nozzle entry configuration of the equipment and the bursting disc safety device. A combined discharge coefficient is denoted by α.

The values of the discharge coefficients given in Table C.1 for the nozzle entry configuration and the bursting disc safety device to be used for compressible fluids are based on experimental work, see references 2 and 3 of the Bibliography.

Table C.1 — Discharge coefficients α

Number	Branch/nozzle type		Discharge coefficient, α
1		In the case of an internally protruding branch/nozzle	0,68
2		In the case of a flush branch/nozzle or a block flange whose inlets are not of hydrodynamic configuration	0,73
3		In the case of a branch/nozzle or a block flange of hydrodynamic configuration, e.g. with rounded or chamfered inlets	0,80

C.2.2.2 Critical and subcritical flow

The flow rate of a compressible fluid through an orifice, such as a bursting disc safety device, increases as the downstream pressure is decreased until critical flow is achieved. A further decrease in the downstream pressure will not result in any further increase of the flow rate.

Critical flow occurs when :

$$\frac{P_b}{P_o} \le \left(\frac{2}{k+1}\right)^{\frac{k}{k-1}} \qquad (1)$$

Subcritical flow occurs when :

$$\frac{P_b}{P_o} > \left(\frac{2}{k+1}\right)^{\frac{k}{k-1}} \qquad (2)$$

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where the validity of Rankine's law is assumed.

C.2.2.3 Discharge capacity at critical flow

C.2.2.3.1 Discharge capacity for any gas/vapour

The discharge capacity at critical flow can be derived from one of the following equations :

$$Q_m = 0{,}2883.C.\alpha\, A_o \sqrt{\frac{P_o}{V_o}} \qquad (3a)$$

or

$$A_o = 3{,}469 \frac{Q_m}{C.\alpha} \sqrt{\frac{V_o}{P_o}} \qquad (3b)$$

or

$$Q_m = C.\alpha\, A_o \cdot P_o \sqrt{\frac{M}{T_o \cdot Z_o}} \qquad (3c)$$

or

$$A_o = \frac{Q_m}{C \cdot \alpha\, P_o} \sqrt{\frac{T_o . Z_o}{M}} \qquad (3d)$$

where the validity of Rankine’s law is assumed ;

and

$$C = 3{,}948 \sqrt{k \left(\frac{2}{k+1}\right)^{(k+1)/(k-1)}} \qquad (4)$$

The value of *k* used to determine *C* should be based on the actual flowing conditions and should be determined from Table 2 of EN ISO 4126-7:2003.

The compressibility factor, Z_o should be assessed from Figure 1 of EN ISO 4126-7:2003. Values of critical temperature and critical pressure for some gases to assist in the determination of Z_o are given in Table 4 of EN ISO 4126-7:2003. However, if insufficient information is available, a value of 1,0 can be used (see also annex D).

C.2.2.3.2 Discharge capacity for steam

a) Dry saturated or superheated :

The discharge capacity for dry saturated or superheated steam can be derived from equations 3a and 3b. However, the values of *k, C* and *v* should be based on the actual flowing conditions of the steam and determined from Table 1 in EN ISO 4126-7:2003.

b) Wet :

The following equation is applicable only to homogenous wet steam of dryness 90% and over (i.e. $x > 0{,}9$) :

$$Q_m = \frac{\left(0{,}2883.C.\alpha\, A_o \sqrt{\frac{P_o}{V_o}}\right)}{\sqrt{x}} \qquad (5)$$

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where :

k, C and v_o are determined from Table 1 in EN ISO 4126-7:2003.

C.2.2.4 Discharge coefficient at critical flow

C.2.2.4.1 The combined discharge coefficients from three specific types of nozzle and bursting disc safety device combinations are listed in Table C.1.

These discharge coefficients are valid where : $0{,}5\,A_1 \leq A_0 \leq A_1$

C.2.2.4.2 Where required by the relevant application standard or where the nozzle/disc configuration is different from the requirements of C.2.1, the comprehensive method should be applied. Annex E gives a test procedure for determining the flow resistance factors to be summed with the frictional losses of vent system piping (upstream and downstream of the bursting disc safety device) in determining the relieving capabilities of a total vent system which includes a bursting disc safety device.

C.2.2.5 Discharge capacity at subcritical flow

The discharge capacity at subcritical flow can be derived from one of the following equations.

$$Q_m = 0{,}2883 C\, K_b\, \alpha\, A_o \sqrt{\frac{P_o}{V_o}} \qquad (6a)$$

or

$$A_o = 3{,}469 \frac{Q_m}{C.K_b.\alpha \sqrt{\dfrac{V_o}{P_o}}} \qquad (6b)$$

or

$$Q_m = C.K_b.\alpha.A_o.P_o \sqrt{\frac{M}{T_o.Z_o}} \qquad (6c)$$

or

$$A_o = \frac{Q_m}{C.K_b.\alpha.P_o} \sqrt{\frac{T_o.Z_o}{M}} \qquad (6d)$$

NOTE 1 For subcritical flow :

$$K_b = \sqrt{\frac{\left(\dfrac{2k}{k-1}\right)\left[\left(\dfrac{P_b}{P_o}\right)^{2/k} - \left(\dfrac{P_b}{P_o}\right)^{(k+1)/k}\right]}{k\left(\dfrac{2}{k+1}\right)^{(k+1)/(k-1)}}} \qquad (7)$$

For values, see Table 3 of EN ISO 4126-7:2003:

NOTE 2 For critical flow, K_b = 1,0.

C.2.2.6 Discharge coefficient at sub critical flow

In the case of sub critical flow conditions, coefficients caused by flow restrictions approximate with increasing pressure ratio p_b/p_o to those which have been demonstrated for incompressible fluids.

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C.2.3 Incompressible fluids

C.2.3.1 Discharge capacity

For incompressible fluids as single phase flow at the inlet and which do not flash to vapour neither partly, nor completely on venting the following equations apply :

$$Q_m = 1,610 . A_o . K_v . \alpha . \sqrt{\rho . \Delta p} \quad (8a)$$

$$A_o = 0,621 \frac{Q_m}{K_v . \alpha . \sqrt{\rho . \Delta p}} \quad (8b)$$

NOTE 1 The effect of static head should be considered.

NOTE 2 Where the liquid has a viscosity less than or equal to that of water at 20 °C, the factor K_v can be taken as 1,0. For greater viscosities the discharge through a given bursting disc safety device will be reduced. The viscosity correction factor K_v is related to the Reynolds number and can be obtained from Figure 2 of EN ISO 4126-7:2003. Reynolds number, R_e can be established from the equation :

$$R_e = 0,3134 \frac{Q_m}{\mu \sqrt{A_o}} \quad (9)$$

NOTE 3 When sizing for viscous relief, first it should be established what the size would be for non-viscous service to obtain a preliminary area. Then the next largest size in calculating R_e should be selected. If the sizing equation shows that the area assumed in calculating R_e was too small, then the calculation should be repeated with the next largest size of a bursting disc safety device.

C.2.3.2 Discharge coefficient

The discharge coefficient is equal to 0,62 or as established in the relevant application standard.

C.2.4 Selection of the bursting disc safety device flow area

The discharge area A_B of a bursting disc safety device should be not less than the calculated required minimum cross-sectional flow area A_0.

$$A_B \geq A_o \quad (10)$$

NOTE If the cross-sectional flow area of a bursting disc safety device being selected exceeds the inlet pipe flow area A_1 then A_1 instead of A_B is the controlling cross-sectional flow area. A_1 should not be less than A_0.

C.3 Comprehensive approach

C.3.1 General

C.3.1.1 This method takes into consideration the reversible and the irreversible changes in pressure throughout the pressure relief system (e.g. nozzle entry, inlet pipe, bursting disc safety device, discharge pipe, and exit to a downstream vessel or to the atmosphere). For further information, see references 7, 8 and 9 of the Bibliography.

C.3.1.2 For analysis of the pressure relief system, information relating to the pressure loss after bursting of the bursting disc safety device is required. Recognised fluid flow calculation methods are adequate so long as the net flow area is known or can be verified and the calculations are based on valid assumptions.

NOTE A burst bursting disc cannot usually be considered to be a round, sharp-edged orifice.

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Annex E gives a procedure for determining the flow resistance coefficient of a bursting disc safety device by flow testing.

C.3.2 Compressible fluids

It is established whether the flow is sub critical or critical.

C.3.2.1 Sub critical flow

In the case of sub critical flow a flow rate is assumed and the changes in pressure through the pressure relief system are calculated. An iterative procedure is used until the flow rate, for which the calculated pressure drop is equal to or less than the pressure difference available, is found.

C.3.2.2 Critical flow

In the case of critical flow a detailed analysis for the entire pressure relief system is carried out in order to determine where the flow chokes and what is the discharge capacity of the pressure relief system.

The recommended method of carrying out the analysis is :

a) determine the possible choke locations starting at the exit to the equipment nozzle ;

b) assume a flow rate and then calculate the changes in pressure throughout the pressure relief system from the exit towards the entry into the equipment nozzle. At each possible choke point the pressure at which the velocity would be equal to the critical velocity can be calculated. In this way, it can be established whether choking would actually occur.

An iterative procedure is used until the flow rate, for which the calculated pressure drop is equal to or less than the pressure difference available, is found.

There are many sizing methods given in published literature but care is necessary in selecting the method relevant to the particular application. The wrong method can lead to serious errors.

The most accurate method of sizing is to use a computer program based on the basic fluid flow equations and thermodynamic/physical property data. For further information, see references 7, 8 and 9 of the Bibliography.

C.3.3 Incompressible fluids

C.3.3.1 General

It is established whether the flow is dependent or independent of the Reynolds number.

C.3.3.2 Flow independent of the Reynolds number

Where the flow is independent of the Reynolds number (complete turbulence) the flow rate can be determined directly by using the basic fluid flow equation.

C.3.3.3 Flow dependent on the Reynolds number

Where flow is dependent on the Reynolds number a flow rate is assumed and the changes in pressure through the pressure relief system are calculated. An iterative procedure is used until the flow rate, for which the calculated drop is equal to or less than the pressure difference available, is found.

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Annex D
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Derivation of compressibility factor Z

The compressibility factor Z at relieving conditions can be obtained from accurate p-v-T data for the gas, using the following equation :

$$Z_o = 10^5 \times P_o . V_o \frac{M}{R . T_o} \quad (11)$$

In the absence of accurate data, the compressibility factor can be obtained from the reduced temperature, $T_r = T_o/T_c$ and the reduced pressure $p_r = p_o/p_c$ of critical pressure of the pure gas as shown in Figure 1 of EN ISO 4126-7:2003.

EXAMPLE The value of Z_o for a gas relieving through a bursting disc safety device with a pressure of 100 bar gauge and a temperature of 70 °C is determined as follows :

Relieving pressure (p_o)	=	100 + 1
	=	101 bar abs.
Relieving temperature (T_o)	=	70 + 273
	=	343 K
Critical pressure (p_c)	=	50,5 bar abs.
Critical temperature (T_c)	=	298 K
$p_r = (p_o/p_c)$ = (101/50,5)	=	2
$T_r = (T_o/T_c)$ = (343/298)	=	1,15
From Figure 1 of EN ISO 4126-7:2003	Z_o =	0,49

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Annex E
(informative)

Flow testing of bursting disc safety devices

E.1 Scope

The procedure provides a test method for determining flow resistance in which the test specimen is a burst bursting disc safety device. The test data is used to establish the flow resistance factor K_R for a particular type of model and size of bursting disc safety device for compressible fluids.

NOTE Methods to derive values of K_R for incompressible fluids are currently being developed and will be included in a future edition of this standard.

Other procedures can be used by agreement between the purchaser and the manufacturer provided that the test requirements, test method, test procedure and derivation of the flow resistance factor can be demonstrated as having accuracy and reliability at least equal to the requirements of this procedure.

E.2 Test requirements

The procedure for determining flow resistance factor of burst bursting disc safety devices is as follows :

E.2.1 Test system

E.2.1.1 General

A recommended test system configuration for compressible fluids is as shown in Figure E.1. Differential pressure measurement devices should be used between pressure taps A and B, B and C, and C and D. The primary element should be either :

— a subsonic inferential meter including orifice plate, flow nozzle and venturi ; or

— a sonic inferential meter including choked nozzles.

The instrumentation required for each type of meter is as follows.

E.2.1.2 Subsonic inferential meters

Measurement of :

a) inlet static pressure ;

b) inlet temperature ;

c) differential pressure.

E.2.1.3 Sonic inferential meters

Measurement of :

a) inlet total (stagnation) pressure ;

b) inlet total (stagnation) temperature.

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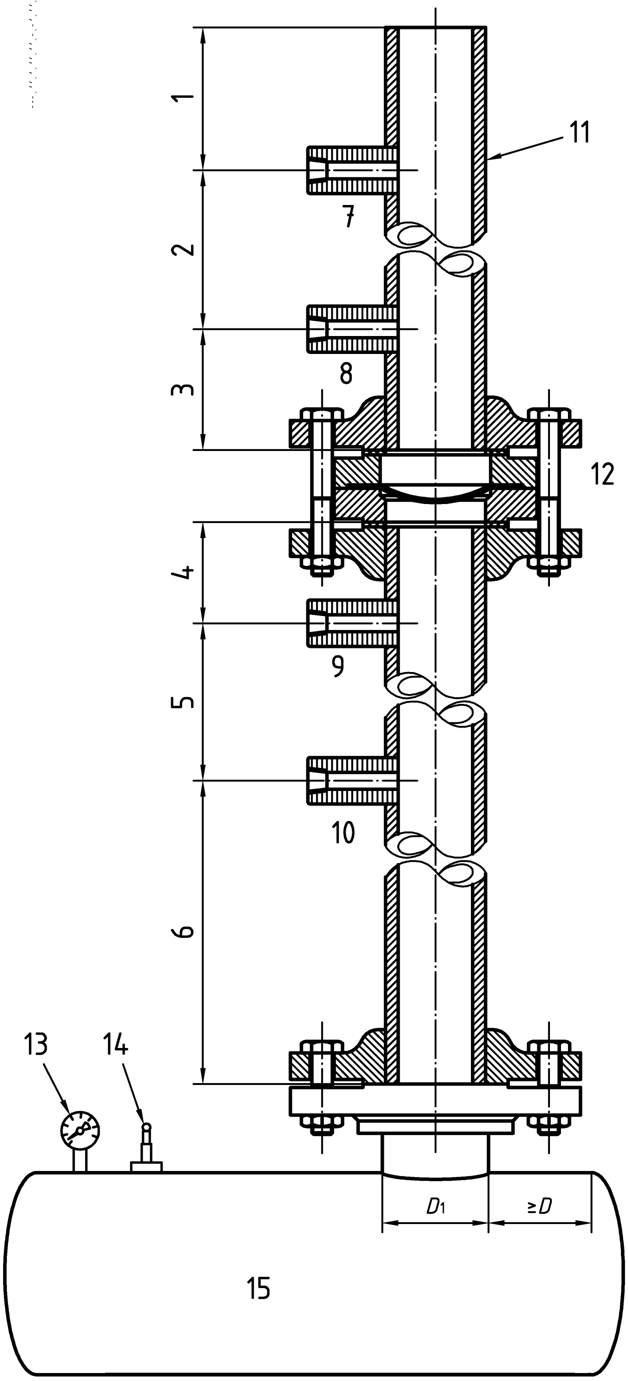

Figure E.1a – Test system configuration

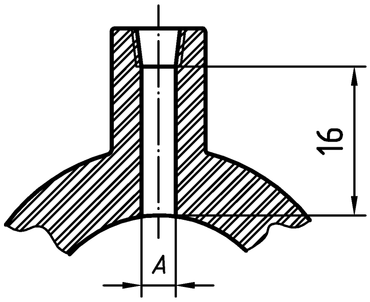

Figure E.1b - Pressure tap detail

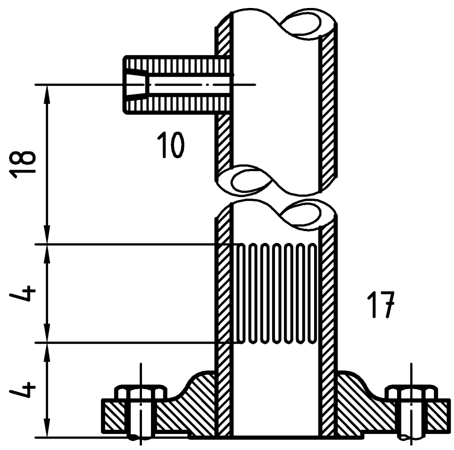

Figure E.1c – Remainder of test rig to be configured as the test rig without straightening vanes

Key

1 15 pipe diameters
2 30 pipe diameters
3 12 pipe diameters
4 2 pipe diameters
5 30 pipe diameters
6 60 pipe diameters
7 Pressure tap D
8 Pressure tap C
9 Pressure tap B
10 Pressure tap A
11 Standard bore schedule 40 clean commercial pipe
12 Bursting disc safety device
13 Pressure gauge
14 Temperature gauge
15 Test vessel
16 Minimum 2,5.A – Recommended 5.A
17 Straightening vanes
18 22 pipe diameters

NOTE For the determination of A, see Table E.1.

Figure E.1 — Measurement of K_R - Recommended test system configuration for compressible fluid

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Table E.1 — Determination of *A*

Pressure tap pipe size	*A* (mm)	
	Not exceeding	Not less than
dn 50	6	3,2
dn 80	9,5	3,2
dn 100 to dn 200	12,5	3,2
dn 250 [a]	19	3,2

[a] Edge of hole should be clean and sharp or slightly rounded free from burrs, wire edges or other irregularities. In no case can any fitting protrude inside the pipe.

E.2.1.4 The test equipment should be such that the uncertainty of the final flow measurement should not exceed ± 2,0% of the measured value and for individual measurements should not exceed ± 0,5 % of the measured value. The uncertainty of temperature measurements should not exceed ± 1 °C. The determination of these limits should be documented and available for review.

E.2.1.5 The diameter of the test vessel should be at least ten times the bursting disc safety device inlet diameter. The discharge pipe should have at least the same nominal size as the bursting disc safety device outlet and should discharge into a system of sufficient size to ensure absence of back pressure.

E.2.1.6 The alignment between the centre of the centre-line of the bursting disc assembly inlet and outlet should be as given in Table E.2.

Table E.2 — Allowable misalignment

Pipe size	Misalignment (mm)
DN 15 to DN 25	0,8
DN 30 to DN 150	1,6
DN 200 and larger	1 % of nominal inner diameter

Each gasket should be positioned so that it does not protrude into the flow stream.

E.2.1.7 The pipe roughness should be verified to fall within the range 2 µm to 46 µm.

E.2.1.8 With no test specimen installed in the system, the difference between the flow resistance factors, determined according to E.5 based on data in accordance with E.4.7, recorded at the minimum pressure and size for the test system, between pressure taps A and B should be within 3 % of the difference between the flow resistance factors of pressure taps C and D.

E.2.2 Test fluids

The test fluids used to determine flow data should be air or other compressible fluids. Saturated vapours are not acceptable as test fluids. Care should be taken to avoid internal icing during the test.

E.2.3 Test specimens

E.2.3.1 Flow resistance certification tests should be conducted at a bursting disc device inlet pressure, which does not exceed 110 % of the specified burst pressure.

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E.2.3.2 For each type or model of bursting disc, the manufacturer should submit for test the required bursting disc safety devices in accordance with E.3 together with the cross-section drawings showing the bursting disc safety device design.

E.2.3.3 The bursting disc safety devices tested should be representative of the bursting disc assembly type, or model for which the resistance factor is required, and should be selected from a type test batch of discs of the same size and type and should be marked in accordance with EN ISO 4126-2.

E.2.3.4 The nominal pipe size dimension of the test system should be the same as that of the bursting disc safety device submitted for testing.

E.2.3.5 The following information should be documented prior to the tests being carried out :

a) complete specification of the bursting disc safety device(s) to be tested ;

b) details of the test system including proposed instrumentation, test and calibration procedures, and demonstration of its limits of uncertainties.

E.2.3.6 For bursting disc safety device designs to be tested, the test specimens should be burst either :

— on the test system immediately prior to flow testing ; or

— by the manufacturer in the presence of an independent witness who will certify the burst test specimens to be used for each flow resistance test.

NOTE This method can be used for bursting discs having a coincident temperature outside the range 15 °C to 30 °C.

E.3 Method of testing

E.3.1 The testing method to establish the flow resistance factor for a particular size, type or model of bursting disc assembly should be carried out using a complete bursting disc safety device including where applicable, a bursting disc holder.

E.3.2 Flow resistance certification of bursting disc devices should be determined by one of the following methods.

E.3.2.1 One size method

a) The certified flow resistance determined by this method should apply only to the bursting disc safety device of the size tested.

b) For each type or model of bursting disc safety device, three bursting discs from the same lot should be individually burst and flow tested in accordance with E.4.

c) The burst pressure should be the minimum for the bursting disc of the size tested.

d) The test results so obtained can be included as applicable in the three size method described in E.3.2.2.

E.3.2.2 Three size method

a) The certified flow resistance determined by this method should apply to all sizes and burst pressures of the design of the bursting disc safety device tested.

b) For each bursting disc safety device, three bursting discs from the same lot should be burst and flow tested in accordance with E.4 for each of three different sizes of the same design.

c) The burst pressure should be the minimum of the bursting disc safety device design for each of the sizes submitted for test.

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E.4 Test procedure

E.4.1 Each instrument used during the test should be serialised or otherwise positively identified. Depending on the type, each instrument should be calibrated. Records of pertinent instrument calibrations should be available for review. Each instrument used during the test should carry a serial number or be otherwise positively identified.

E.4.2 Prior to conducting a flow test, a preliminary test should be made without the test specimen to ensure the absence of leaks in the test apparatus and that all differential pressure measurement devices are functioning properly and within their calibrated pressure range.

E.4.3 Atmospheric pressure at the test site should be measured with a barometer.

E.4.4 The test specimen should be installed in accordance with E.2.

E.4.5 If the bursting disc is to be burst in the test system, the pressure recorded at the upstream pressure tap B should be increased as specified in 14.3.4.7 of EN ISO 4126-2:2003 maintaining the temperature to ensure it is in the range 15 °C to 30 °C until the bursting disc bursts. The bursting disc burst pressure, and any other desired or pertinent characteristics should be observed and recorded.

E.4.6 The flow rating pressure should be established and maintained at a value equal to or less than 110 % of the observed burst pressure until the flow instruments indicate a steady state.

E.4.7 The following measurements should be simultaneously recorded (it is preferable to use a data acquisition system for these measurements).

E.4.7.1 Using a subsonic inferential meter :

a) test system pipe inlet pressure ;

b) test system pipe inlet temperature ;

c) flowmeter inlet static pressure ;

d) flowmeter inlet total temperature ;

e) flowmeter differential pressure ;

f) pressure at pressure tap B ;

g) differential pressure between pressure taps A and B ;

h) differential pressure between pressure taps B and C ;

i) differential pressure between pressure taps C and D.

E.4.7.2 Using a sonic inferential meter :

a) test system pipe inlet pressure ;

b) test system pipe inlet temperature ;

c) flowmeter inlet total pressure ;

d) flowmeter inlet total temperature ;

e) pressure at pressure tap B ;

f) differential pressure between pressure taps A and B ;

g) differential pressure between pressure taps B and C ;

h) differential pressure between pressure taps C and D.

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E.4.8 After recording measurements, two comparisons should be made to confirm the validity of the test results, after calculations in accordance with E.5.2.3, equation number 22, are completed.

E.4.8.1 It should be verified that the difference between flow resistance factors of pressure taps C and D (downstream of test specimen) is within 3 % of the value of the difference between the flow resistance factors of pressure taps A and B (upstream of test specimen).

E.4.8.2 All measurements should be repeated with no bursting disc installed in the test system to verify that the difference between the flow resistance factors of pressure taps C and D is within 3 % of the differences between the flow resistance factors of pressure taps A and B (see E.2.1.7).

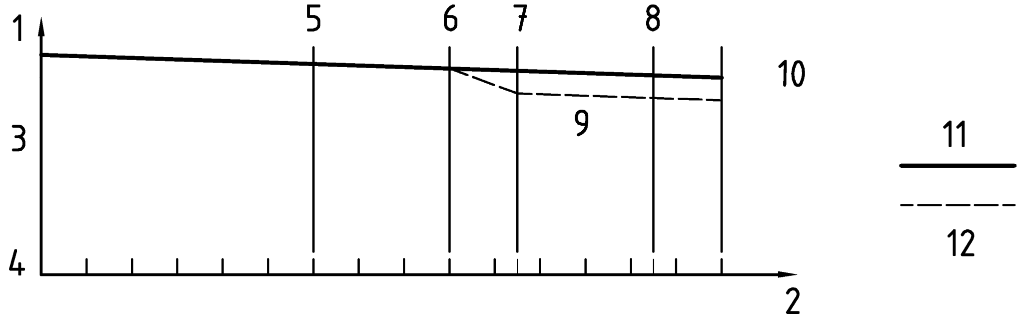
If the above criteria are found not to have been satisfied, the test shall be invalid.

E.4.9 Should any bursting disc safety device fail to meet or exceed the specified performance requirements for burst pressure and flow resistance, the test should be repeated at the rate of two replacement devices, selected and tested by the same procedure as above for each device that failed.

E.5 Determination of flow resistance factor K_R

E.5.1 Required data

Data relating to the test system, test fluid and measurements recorded during the test is used to derive the flow resistance factor K_R for each test specimen. This is illustrated diagrammatically in Figure E.2.



Key

1 P1
2 Distance in pipe diameters (*d*)
3 Pressure
4 Test system pipe inlet
5 Pressure tap A
6 Pressure tap B
7 Pressure tap C
8 Pressure tap D
9 Pressure drop caused by flow resistance of test specimen installation
10 Test rig pipe outlet
11 Without test specimen installed
12 With test specimen installed

Figure E.2 — Determination of K_R - Flow resistance measurements on test rig system

E.5.2 Evaluation of data

The flow resistance factor K_R, which is a dimensionless expression of the velocity head loss attributed to the presence in a piping system of a burst bursting disc safety device is derived by the following equations.

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E.5.2.1 The Mach number at the pipe inlet of the flow test system is derived :

Mass velocity

$$G = \frac{Q_{\mathrm{m}}}{\left(\pi \frac{D^2}{4} \right)} \tag{12}$$

Mach number

$$Ma_1 = \frac{1}{60 \times 60 \times 10^5} \times \frac{G}{p_{\mathrm{B}}} \sqrt{\frac{Y_1 \frac{(k+1)}{(k-1)}}{M \frac{K}{R.T_{\mathrm{B}}}}} \tag{13}$$

Solve by iteration

$$Y_1 = 1 + \frac{(k-1) Ma_1^2}{2} \tag{14}$$

E.5.2.2 The pressure and temperature at the inlet of the flow test system pipe is derived :

$$p_1 = p_{\mathrm{B}} \left(\frac{2}{2 + (k-1) Ma_1^2} \right)^{\frac{1}{2}} \tag{15}$$

$$T_1 = T_{\mathrm{B}} \left(\frac{p_1}{p_{\mathrm{B}}} \right)^{\frac{(k-1)}{k}} \tag{16}$$

E.5.2.3 The flow resistance factor between the test system pipe inlet and each pressure tap is derived for each of the upstream and downstream pressure taps using the following equations for each tap :

Temperature at pressure tap, T_{tap}

$$T_{\mathrm{tap}} = T_1 \left[\frac{-1 + \sqrt{1 + 2(k-1) Ma_1^2 \left(\frac{p_1}{p_{\mathrm{tap}}} \right)^2 \left(1 + (k-1) \frac{Ma_1^2}{2} \right)}}{(k-1) Ma_1^2 \left(\frac{p_1}{p_{\mathrm{tap}}} \right)^2} \right] \tag{17}$$

Sonic velocity at pressure tap, C_{tap}

$$C_{\mathrm{tap}} = \sqrt{\frac{k.R.T_{\mathrm{tap}}}{M}} \tag{18}$$

Specific volume at pressure tap, v_{tap}

$$v_{\mathrm{tap}} = \frac{1}{10^5} \left(\frac{R.T_{\mathrm{tap}}}{M.p_{\mathrm{tap}}} \right) \tag{19}$$

Mach number at pressure tap, Ma_{tap}

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$$Ma_{tap} = \frac{G}{60 \times 60}\left(\frac{v_{tap}}{C_{tap}}\right) \tag{20}$$

Expansion factor at pressure tap, Y_{tap}

$$Y_{tap} = 1 + \frac{(k-1)\left(Ma_{tap}\right)^2}{2} \tag{21}$$

Total flow resistance factor to pressure tap

$$K_{tap} = \frac{\frac{1}{Ma_1^2} - \frac{1}{Ma_{tap}{}^2} - \left(\frac{k+1}{2}\right) \times \ln\left[\frac{Ma_{tap}{}^2 \times Y_1}{Ma_1^2 \times Y_{tap}}\right]}{k} \tag{22}$$

E.5.2.4 The flow resistance factor for a fitting installed in a piping system can generally be expressed as the equivalent flow resistance of a length of pipe of the same nominal size in accordance with the equation :

$$K_R = f\left(\frac{4L}{D}\right) \tag{23}$$

The value of K_R for the test specimen should be determined using the following calculation method.

E.5.2.4.1 A friction factor is calculated for the test system pipe from the recorded test data for pressure taps A and B. The difference between the K_{tap} calculated as above for each of these pressure taps is related to the distance between them by the equation :

$$f_{A-B} = \frac{\left(K_{tapB} - K_{tapA}\right)}{120} \tag{24}$$

E.5.2.4.2 This friction factor and the difference between the flow resistance factors at pressure taps B and D are used to calculate an equivalent length of pipe between these pressure taps :

$$\frac{L_{calc}}{D} = \left(\frac{K_{tapD} - K_{tapB}}{4 f_{A-B}}\right) \tag{25}$$

E.5.2.4.3 This length L_{CALC} is compared with the actual distance between pressure taps B and D and the difference is used to derive K_B for the test specimen.

$$K_R = f_{A-B}\left(\frac{4L_{CALC}}{D} - \frac{4L_{ACT}}{D}\right) \tag{26}$$

NOTE The actual length L_{ACT} distance between pressure taps B and D is 44 x D.

EXAMPLE For a DN 50 bursting disc safety device, actual length B-D is 2200 mm.

E.5.3 All values determined for K_R for each model of bursting disc safety device should be within range of values for K_R which is calculated by first determining the average of the measured values of K_R for all sizes tested. The absolute value of deviation of each measured value from this average is used to derive a mean deviation. The acceptable tolerance is plus or minus three times this mean deviation.

If a measured K_R falls outside this tolerance, it should be replaced by conducting two further tests from which a new average of K_R and mean deviation is calculated from which the final acceptance tolerance is established.

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E.6 Application of flow resistance factor K_R

E.6.1 K_R should be applied to venting systems in which turbulent flow conditions are expected.

E.6.2 A change in material for bursting discs and for other components of bursting disc assemblies, such as seals, support rings, and vacuum supports, is not considered a design change and does not require re-testing.

E.6.3 The flow resistance for bursting disc devices tested with non-pressure containing disc items, such as seals, support rings, and vacuum supports, is applicable for the same bursting disc device design without seals, support rings, or vacuum supports.

E.6.4 Additional linings, coating or platings can be used for the same design of bursting disc devices provided that :

a) the manufacturer has performed a verification bursting test of bursting discs with the additional lining, coating or platings and has documented that the addition of these material does not affect the bursting disc opening configuration ; and

b) such verification tests shall be conducted with bursting discs of the smallest size and minimum burst pressure for which the flow resistance with additional materials is to be used.

E.6.5 When changes are made in the design of a bursting disc safety device which affects the opening, and/or burst performance characteristics of the device, new tests in accordance with this document should be performed.

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