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Bursting discs and bursting disc devices

Disques de rupture et dispositifs à disque de rupture

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Contents

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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.

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.

International Standard ISO 6718 was prepared by Technical Committee ISO/TC 185, *Safety devices for protection against excessive pressure*, Sub-Committee SC 2, *Bursting discs*

This second edition cancels and replaces the first edition (ISO 6718:1985), of which it constitutes a technical revision.

Annexes A, B, C and D of this International Standard are for information only.

Bursting discs and bursting disc devices

Section 1: General

1.1 Scope

This International Standard specifies requirements for bursting discs and bursting disc devices used to protect pressure vessels, piping or other enclosures from excessive pressure *or* vacuum. They are designed to burst or vent when the pressure differential across the bursting disc exceeds a predetermined value at a predetermined temperature.

1.2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this Internationa! Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 9001:1987, *Quality systems — Model for quality assurance in design/development, production, installation and servicing.*

1.3 Definitions

For the purposes of this International Standard, the following definitions apply.

1.3.1 purchaser: Organization or individual who purchases the finished bursting disc or bursting disc device.

1.3.2 manufacturer: Organization which designs, constructs and tests the bursting disc or bursting disc device in accordance with the purchaser's specification.

1.3.3 bursting pressure: Value of the pressure differential across the bursting disc at which a bursting disc device functions.

It may be specified as a maximum or minimum value.

1.3.4 specified bursting pressure: Pressure, quoted with a coincident temperature, specified by the purchaser when defining the bursting disc requirement.

It may be specified as a maximum or minimum value.

1.3.5 average bursting pressure: Arithmetic average value of the bursting pressures, at the coincident temperature of the test bursts carried out, of a batch of bursting discs.

1.3.6 coincident temperature: Temperature used in conjunction with a bursting pressure.

1.3.7 operating temperature: Average temperature of the bursting disc and the surrounding parts during normal operation.

1.3.8 bursting tolerance: Maximum variation in test results in equal positive and negative quantities or percentages related to the average bursting pressure. When a zero manufacturing range is stated, the tolerance applies directly to the specified bursting pressure.

1.3.9 manufacturing range: Range of pressure within which the average bursting pressure of a batch of bursting discs shall fall in order to be acceptable for a particular application as agreed between the manufacturer and the purchaser.

1.3.10 performance tolerance: Range of pressure, in positive and negative quantities or percentages, which includes both the manufacturing range and the bursting tolerance at a coincident temperature, and which is applied directly to the specified bursting pressure.

1.3.11 foil: Sheet or strip used for the manufacture of metallic bursting discs.

1.3.12 batch: Group of bursting discs of the same type, size, average bursting pressure and coincident temperature, manufactured from material of the same identity and properties, and made as a single group.

1.3.13 bursting disc device: Non-reclosing pressure-relief device actuated by differential pressure and designed to function by the bursting or venting of the bursting disc(s). It is the complete assembly of installed components including, where appropriate, the bursting disc holder.

1.3.14 bursting disc assembly: Complete assembly of components which are installed in the bursting disc holder to perform the desired function.

1.3.15 bursting disc: Pressure-containing and pressure-sensitive component of a bursting disc device.

1.3.16 bursting disc holder: That part of a bursting disc device which retains the bursting disc assembly in position,

1.3.17 back pressure: Static pressure existing at the outlet of a bursting disc device at the time the device is required to operate.

It is the result of pressure in the discharge system from other sources or as a result of vacuum on the upstream side.

1.3.18 back pressure support: That component of a bursting disc assembly which prevents the failure of the bursting disc due to back pressure differential.

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

1.3.19 baffle plate: Plate attached to the vent side of a bursting disc device or system to redirect discharge and/or to reduce recoil.

1.3.20 muffled outlet: Component of a bursting disc device which disperses the discharge.

1.3.21 stiffening ring: Integral component of the bursting disc assembly used primarily for the stiffening of fragile bursting discs.

1.3.22 coating: Layer of metallic or non-metallic material applied by brush, spraying, dipping, fluidized bed or other similar method to components of a bursting disc device.

1.3.23 lining: Additional sheet or sheets of material forming part of the bursting disc assembly or holder. The lining may be metallic or non-metallic.

1.3.24 plating: Metal layer applied to a bursting disc or disc holder by a plating process.

1.3.25 excess flow valve: Device which permits limited flow. When this flow is exceeded the valve closes.

1.3.26 conventional domed bursting disc: Bursting disc which is domed in the direction of the bursting pressure and designed to fail in tension.

(See figures 1 and 2.)

1.3.27 conventional slotted lined bursting disc: Conventional domed bursting disc made up of two or more layers, one of which is slit or slotted so as to reduce its strength and to control the bursting pressure of the bursting disc.

(See figure 3.)

1.3.28 reverse domed bursting disc: Bursting disc which is domed against the direction of the bursting pressure and designed to fail by buckling, bending or shearing.

(See figure 4.)

1.3.29 graphite bursting disc: Bursting disc manufactured in graphite and designed to fail by bending or shearing.

1.3.30 temperature shield: Device which protects a bursting disc from excessive temperature.

1.3.31 bursting disc device discharge area: Area which is the minimum cross-sectional flow area of the bursting disc device taking into consideration the possible reduction in the cross-section owing to, for example, back pressure supports, catching devices or parts of the bursting disc which remain after bursting or venting.

1.3.32 bursting disc device discharge capacity: Rate at which a bursting disc device can discharge fluid after bursting or venting of the bursting disc.

1.3.33 independent authority: That authority which, in the country concerned, bears responsibility for ail aspects of surveillance of tests, checking of calculations and certification of bursting disc device discharge capacities.

1.3.34 service life: Time period beginning at the installation of a bursting disc assembly and ending when the bursting disc is replaced or when it bursts.

1.3.35 operating pressure: Pressure to which the bursting disc is exposed during normal operation.

1.3.36 inspection authority: Independent authority or association which verifies compliance with this International Standard.

1.3.37 lot of material: Unless otherwise stated in appropriate regulations or standards,

a) for metal; all material issuing from the same heat number and heat treatment batch and having a specified thickness with tolerances to an appropriate standard;

b) for impregnated graphite; all material of a specific grade and impregnant.

1.3.38 relieving pressure: Maximum pressure under discharge conditions in the pressurized system. It may differ from the bursting pressure of the bursting disc device (see A.1.5).

1.3.39 relieving temperature: Maximum temperature under discharge conditions in the pressurized system. It may differ from the coincident temperature specified for the bursting disc device.

1.4 Selection

1.4.1 Bursting discs are differential pressure devices, and therefore the pressure on each side of the bursting disc shall be taken into account.

1.4.2 As highly stressed components, bursting discs have a limited service life and may require replacement at regular intervals. The frequency of replacement depends on the type and material of the bursting disc, the corrosive nature of the environment, the fluctuations in operating temperature, operating pressure and back pressure, the ratio of differential pressure to minimum bursting pressure, the resistance to creep and fatigue and other operating conditions.

1.4.3 Bursting disc 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, lining or other suitable means which shall be supplied only by the manufacturer (see section 3).

1.4.4 The choice of the appropriate bursting disc material depends on the chemical and physical conditions that will be met on each side of the bursting disc when it is in service.

1.4.5 To function properly, bursting discs, and back pressure supports where required, shall be installed in accordance with the recommendations of the manufacturer.

1.4.6 When requested by the purchaser, data regarding the variation in bursting pressure with relation to the temperature for a batch of bursting discs shall be provided by the manufacturer.

NOTE 1 The bursting pressure of a bursting disc according to its material and type may vary with temperature. Generally a bursting disc operating at high temperatures has a lower bursting pressure than that at room temperature; a bursting disc operating at below room temperature has a higer bursting pressure than that at room temperature.

When a bursting disc is specified with a bursting pressure at a coincident temperature to protect a system, the bursting disc may not give the necessary protection at a lower temperature. The system has to be considered with regard to the bursting pressures of the bursting disc over the temperature range of the system.

Bursting discs may be protected from excessive temperature by suitable location, a temperature shield or by other means. The influence of the temperature protection should be considered when establishing the coincident temperature of the bursting disc.

1.4.7 The manufacturer's advice shall be sought when selecting a bursting disc for a particular application

1.4.8 When reverse domed bursting discs are required for liquid relief the manufacturer shall be consulted.

1.5 Application

1.5.1 Subject to the requirements of appropriate regulations or standards, bursting discs may be used either as the sole safely device or in conjunction with safety valves.

1.5.2 The use of a bursting disc as a pressure-relieving device may be preferred in the following cases:

a) where pressure rise may be so rapid that the inertia of a safety valve would be a disadvantage;

b) where even minute leakage of the fluid cannot be tolerated under normal conditions;

c) where service conditions may involve deposition which could.render a safety valve inoperative;

d) where cold service conditions could prevent a safety valve from operating.

1.5.3 Where a bursting disc alone is used as the relieving device, its maximum bursting pressure at the coincident temperature shall comply with the appropriate regulations or standards covering the system to be protected.

1.5.4 The selection of bursting discs for use on vessels which may be involved with extremely rapid and uncontrolled changes in pressure requires special consideration not covered by this International Standard.

1.5.5 Bursting disc devices may be used in combination with safety valves as permitted by the appropriate regulations or standards, and as specified below. The application of the bursting discs shall not adversely affect the operation of the safety valve nor result in excess pressure to the system.

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

a) in series, to protect the safety valve against corrosion, fouling or service 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 pressure system following venting of the bursting disc;

d) in parallel, as an additional safeguard.

1.5.5.2 A bursting disc device may be installed before the inlet of a safety valve if the following requirements are met.

a) The maximum bursting pressure at the coincident temperature shall comply with the appropriate regulations or standards for the system being protected.

b) If the discharge capacity and the operating characteristics of the particular combination of safety valve and bursting disc device have been established by test in accordance with appropriate regulations or standards the test results shall be used.

c) Where a combination has not been tested

   1) the bursting disc device discharge area shall be such as to satisfy the safety valve inlet piping pressure drop requirements stated in the appropriate regulations or standards,

   2) the bursting disc device discharge area shall be not less than 80 % of the nominal area of the safety valve inlet, and

   3) the flow capacity of the combination shall be assumed to be no greater than 80 % of the rated relieving capacity of the safety valve alone.

d) The space between the bursting disc and safety valve shall be provided with a means for monitoring any pressure build-up. This cavity may also be vented by means of an excess-flow valve

NOTE 2 Bursting discs, since they are pressure differential devices, require a higher system pressure to burst if pressure builds up in the space between the bursting disc and safety valve, which will occur should leakage develop in the bursting disc due to corrosion or other causes.

e) In situations where fragmentation or release of bursting disc material may occur, the installation shall be designed so that parts or particles of the bursting disc cannot render the safety valve inoperative nor reduce the flow area of the safety valve.

1.5.5.3 A bursting disc device may be installed after the outlet of a safety valve if the following requirements are met.

a) The safety valve is so designed that its operating characteristics shall not be adversely affected by the bursting disc installed.

b) The system shall be designed so that the safety valve opens at its set pressure. The space between the safety valve disc and the bursting disc shall be vented or drained to prevent pressure build-up.

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

   1) the pressure permitted by the safety valve manufacturer,

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

   3) the pressure permitted by the appropriate regulations or standards.

d) In installations where fragmentation or release of bursting disc material may occur, the system shall be designed so that the performance of the safety valve is not impaired and adequate venting is provided.

e) On bursting, the bursting disc device discharge area shall not affect the discharge capacity and the operating characteristics of the safety valve.

f) The contents of the protected system shall be clean fluids, free from gumming or fouling matter, so that accumulation in the space between the safety valve inlet and the bursting disc (or in any other outlet that may be provided) does not obstruct the outlet.

NOTE 3 A bursting disc assembly on the discharge side of a safety valve should not be replaced while there is any possibility of the safety valve opening.

1.5.5.4 A bursting disc device may be installed both before and after a safety valve provided that the requirements of 1.5.5.2 and 1.5.5.3 are taken into consideration.

1.5.5.5 A bursting disc device fitted in parallel with a safety valve as an additional safeguard, such as to protect the system against the consequence of a rapid rise in pressure, shall be specified to burst at a pressure not exceeding that specified in the appropriate regulations or standards.

1.5.5.6 A bursting disc device may be fitted in series with a second bursting disc device. In such cases the system shall be designed in accordance with the following requirements.

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

b) The space between the bursting discs shall be provided with a means of monitoring any pressure build-up. This space may also be vented by means of an excess-flow valve.

NOTE 4 Bursting discs, since they are pressure differential devices, require a higher system pressure to burst 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.

1.6 Installation

1.6.1 A bursting disc device shall be placed as close as practicable to the space it is intended to protect, taking into account pressure pulses, temperature conditions, etc. The discharge system shall be of ample size and as straight and as short as practicable, terminating in such a way as to avoid dangerous or damaging conditions arising on venting.

1.6.2 Bursting disc devices shall be mounted so that they are accessible for replacement and protected from accidental damage. Consideration shall be given to the effects of weather, including freezing of the discharge pipe and possible corrosion due to the atmosphere.

1.6.3 Adequate precautions shall be taken to prevent deposition on the pressure side of the bursting disc, and in the part leading to it, of sublimates or other solids that could affect the safe operation of the bursting disc.

Casual liquid or foreign matter shall, for similar reasons, be prevented from accumulating on the vent side of the bursting disc and within the discharge pipe.

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

1.6.4 The purchaser shall ensure that provision is made to absorb the effect of reaction forces on the vessel and associated pipework which will arise when the bursting disc bursts or vents.

1.6.5 If the bursting of a bursting disc can discharge a flammable fluid, the danger of ignition in the discharge pipe shall be considered and appropriate measures taken to minimize the hazard.

1.6.6 Bursting discs shall be examined for defects immediately before installation and care shall be taken during their assembly, and particularly during that of thin bursting discs.

1.6.7 In situations where fragmentation or release of bursting disc material may occur, any piping beyond the bursting disc shall be so designed that it shall not be obstructed by fragments from the bursting disc device.

1.6.8 The manufacturer's installation instructions, and in particular the directional arrow, bolting torque instructions and the reference to the use of gaskets, shall be strictly followed.

NOTE 5 If the components are assembled incorrectly or the bursting disc device is installed incorrectly, the bursting disc may burst or vent at a system pressure higher or lower than that expected.

1.7 Discharge capacity

1.7.1 Guidance for determining the mass flow rate, for single-phase flow, through a discharge system containing a bursting disc device is given in annex A,

The manufacturer shall, when requested by the purchaser, provide information relating to the bursting disc device.

Such information may include

a) the bursting disc device discharge area (see 1.3.31), and

b) the pressure loss (resistance coefficient).

Unless specified otherwise in appropriate regulations or standards, the information may be established by

a) tests on actual bursting disc devices, or

b) using established scientific data.

Alternatively, by agreement between the purchaser and the manufacturer, conservative values may be used.

1.7.2 The discharge area of a bursting disc device, used as the primary relief device, shall be sufficient to discharge the maximum quantity of fluid that can be generated or supplied to a pressure system whilst preventing the pressure from exceeding the pressures permitted by appropriate regulations or standards covering the system to be protected.

1.8 Information to be supplied by the purchaser

1.8.1 General

Where possible, the minimum information specified in 1.8.2 to 1.8.5 shall be supplied by the purchaser with every enquiry, to assist the manufacturer in specifying a suitable bursting disc device for a particular application.

1.8.2 Application details

The following shall be specified:

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

b) intended application of the bursting disc device; state whether 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 equipment or system;

d) the fluid which may come in contact with any part of the bursting disc 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 and pressure (including back pressure) to which the bursting disc device may be subjected; rate and frequency of pressure changes, if applicable;

0 expected maximum pressure and temperature during relieving conditions.

1.8.3 Bursting disc device operating details

The following shall be specified:

a) maximum specified bursting pressure and coincident temperature;

b) minimum specified bursting pressure and coincident temperature;

c) rate of change in the pressure with respect to the bursting pressure, where appropriate;

d) bursting disc device theoretical discharge capacity, required to prevent accumulated pressure exceeding allowed maximum;

e) minimum bursting disc device discharge area required;

f) materials which the purchaser, from a knowledge of the process, regards as suitable for consideration in the selection of the bursting disc device material(s);

g) materials which may not be used for safety, corrosion or other reasons.

1.8.4 Installation details

The following shall be specified:

a) physical location of the bursting disc device in the system, preferably in the form of a sketch;

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

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

d) type and preferred material of bursting disc holder (see 2.2);

e) form and finish of external mating surfaces if different than the manufacturer's standard.

1.8.5 Special details

The following shall be specified:

a) inspection and certification requirements additional to those defined in this International Standard;

b) special features required in the bursting disc device (e.g. excess-flow valve, pressure-monitoring device, jacking bolts, lifting rings);

c) special features of application not stated elsewhere,

1.9 Quality assurance

The manufacturer shall establish, document and maintain an effective and economical quality assurance system to ensure and demonstrate that the bursting discs and bursting disc devices conform to the specified requirements (see ISO 9001).

The manufacturer shall make available to the inspection authority at the manufacturer's works a current copy of the written description of the quality system.

The manufacturer's quality system shall provide for the inspection authority at the manufacturer's works to have reasonable access to all documents necessary for the inspection authority to perform its duties. Such access to documentation shall be subject to any confidentiality requirements and procedures laid down in the manufacturer's quality system. The manufacturer may provide such access either to his own files of such documents or by providing copies to the inspection authority.

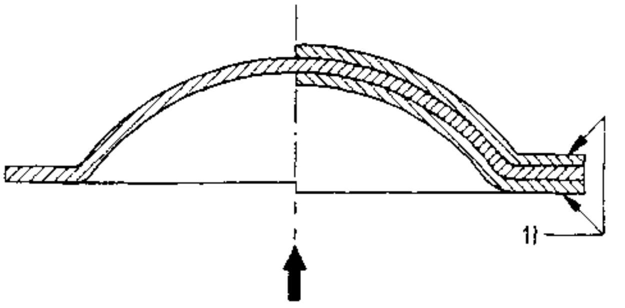
NOTE 6 Annex C provides a typical outline of subjects for inclusion in the quality system.

Section 2: Components of bursting disc devices

2.1 Bursting discs

2.1.1 Materials

All materials including linings, coatings and platings used for the manufacture of bursting discs shall have uniform properties suitable for the working environment in which the bursting discs are to be used. The material in the final form shall be free from defects which may lead to premature failure.



1) The bursting disc may be multilayered.

Figure 2 — Conventional simple domed bursting disc with flat seat

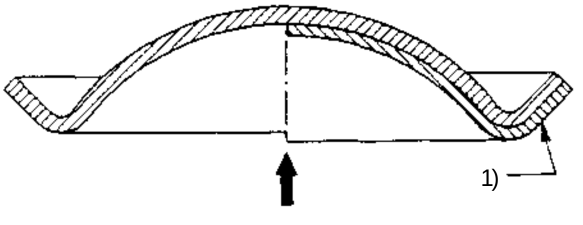
2.1.2 Conventional domed bursting discs

Conventional domed bursting discs are domed in the direction of the subsequent applied bursting pressure. These bursting discs shall be domed by a means capable of producing a permanent set such that no further plastic flow will occur initially when the bursting disc is subjected to its intended operating conditions. Conventional domed bursting discs burst or vent in tension and comprise the following types:

a) conventional simple domed bursting discs (see figures 1 and 2);

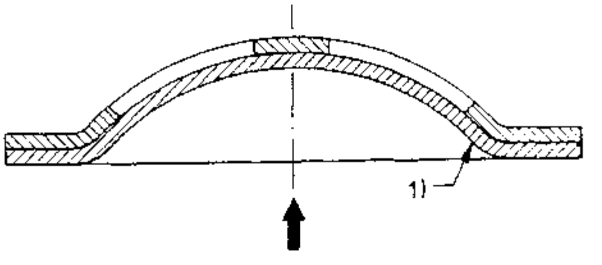
b) conventional slotted lined bursting discs (see figure 3);

c) other types which meet the requirements of this International Standard.



1) The bursting disc may be multilayered.

Figure 1 — Conventional simple domed bursting disc with angle seat



1) The bursting disc may be multilayered.

Figure 3 — Conventional slotted lined bursting disc

2.1.3 Reverse domed bursting discs

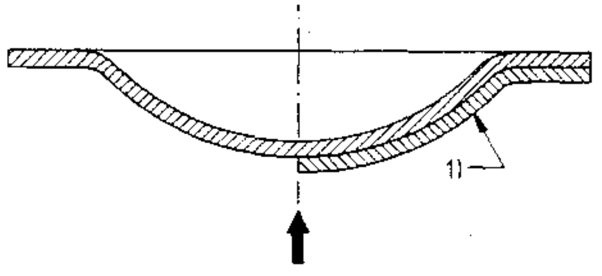
Reverse domed bursting discs are domed against the direction of the bursting pressure (see figure 4) and are designed to fail by buckling under pressure. They include the following types:

a) reverse domed bursting discs with knife blades, which open by being cut during reversal of the dome;

b) reverse domed bursting discs having lines of weakness (without knife blades), which open along these lines when the dome reverses at the bursting pressure;

c) reverse domed bursting discs having a slip or tear-away design (without knife blades), which vent by being expelled downstream from the holder; a catching device may be provided;

d) other types which meet the requirements of this International Standard.



1) The bursting disc may be multilayered.

Figure 4 — Reverse domed bursting disc

2.1.4 Graphite bursting discs

2.1.4.1 Genernl

Graphite bursting discs are designed to fail as a result of bending or shearing.

Graphite bursting discs are normally flat and are designed such that upon bursting a full bore opening is obtained. They comprise various types as specified in 2.1.4.2 to 2.1.4.4.

2.1.4.2 Replaceable element bursting disc

Holders are required for use with replaceable element bursting discs. Figure 5 shows a typical replaceable element bursting disc.

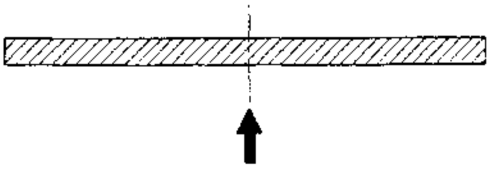


Figure 5 — Replaceable element bursting disc

2.1.4.3 Monobloc bursting disc

Monobloc bursting discs are installed directly between flanges. Three typical monobloc designs are illustrated in figures G to 8.

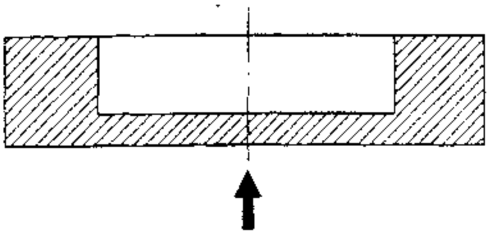


Figure 6 — Monobloc bursting disc recessed on the outlet side

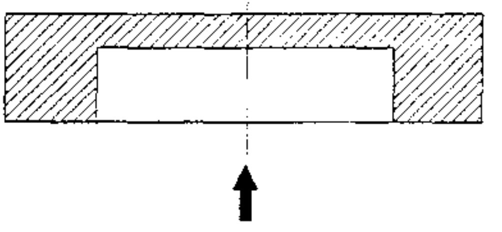


Figure 7 — Monobloc bursting disc recessed on the inlet side

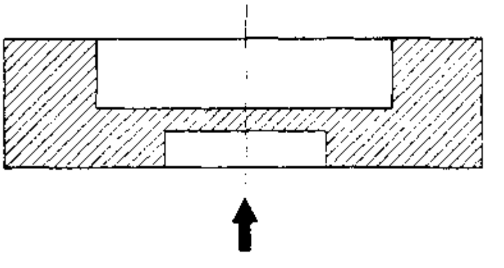


Figure 8 — Monobioc bursting disc recessed on Doth sides

Figure 6 shows a design in which the bursting pressure shall only be applied to the flat face of the monobloc bursting disc.

Figure 7 shows a similar bursting disc but the design is such that the bursting pressure shall only be applied into the recess. For this type of bursting disc, the bore of the vent-side mounting local fo the bursting disc shall be in accordance with the manufacturer's instructions. Normally this bore will be greater than the inside diameter of the recess

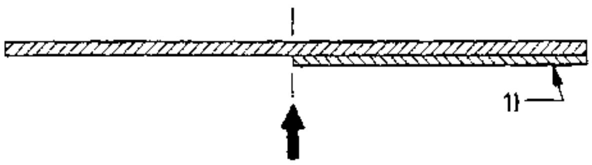
Figure 8 is typical of designs where the bursting disc has a recess on both sides and in which the bursting pressure shall only be applied into the smaller diameter recess.

2.1.4.4 Other types

Other types of graphite bursting discs are allowed provided that they meet the requirements of this International Standard.

2.1.5 Other designs

Other designs, including flat bursting discs (see figure 9), are allowed provided that they meet the requirements of this International Standard.



1) The bursting disc may be multilayered.

Figure 9 — Flat bursting disc

2.2 Bursting disc holders

2.2.1 Material(s)

The materiai(s) of the bursting disc holder shall be as agreed between the manufacturer and purchaser. The use of corrosion-resistant material(s) for the vent side is recommended because corrosion of this part of the bursting disc holder may cause damage to the bursting disc, leading to premature failure when pressure is applied.

2.2.2 Design

2.2.2.1 The bursting disc holder has a substantial influence on the bursting pressure and the correct operation of the bursting disc; it shall adequately secure and support the bursting disc in operation. Each bursting disc shall be used only with its correctly designed and manufactured bursting disc holder.

A bursting disc holder when installed shall apply, or transmit, a clamping load sufficient to ensure the correct operation of the bursting disc.

2.2.2.2 The design of a bursting disc holder shall be such that, for practical purposes, the bursting disc assembly is effectively sealed when correctly installed.

2.2.2.3 The bursting disc holder as supplied by the manufacturer shall not be modified in any way except with the approval of the manufacturer.

2.2.2.4 Where reasonably practicable, the thickness of that part of the bursting disc holder into which the dome of the bursting disc protrudes shall be greater than the height of the dome of the bursting disc so as to prevent damage to it during installation. If this is not reasonably practicable, other means may be used to protect the bursting disc during installation.

2.2.3 Types

2.2.3.1 Capsule/insert bursting disc holder (see figure 10)

A capsule/insert bursting disc holder is designed to be installed centrally within the flange bolts. Accurate centralization of the bursting disc device within the supporting flanges is essential for correct bursting disc functioning and effective flange gasket sealing. Centralization may be achieved by one of the following means, as agreed by the manufacturer and purchaser:

a) the outside diameter is such that the bursting disc holder or device is accurately located within the bolts of the supporting flanges;

b) by use of locating collars;

c) by manual adjustment during fitting,

d) by other suitable means.

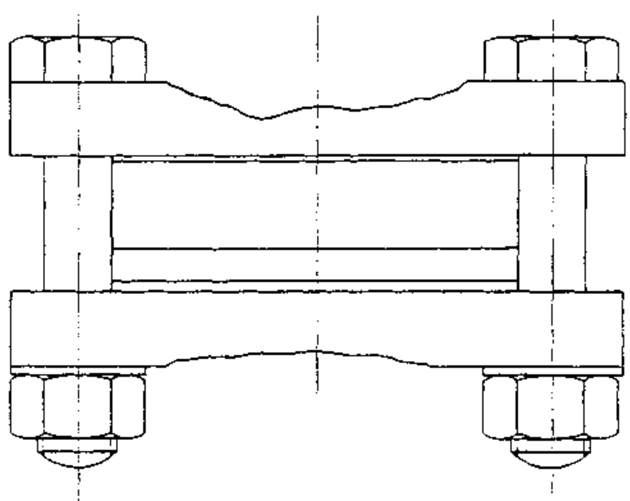


Figure 10 — Capsule/insert bursting disc holder

2.2.3.2 Full diameter bursting disc holder (see figures 11 and 12)

A full diameter bursting disc holder comprises a pair of flanges or other type of housing which normally has the same outside diameter as any companion flanges. The connections to the mating pipework may be threaded, welded or flat, depending on the purchaser's requirements.

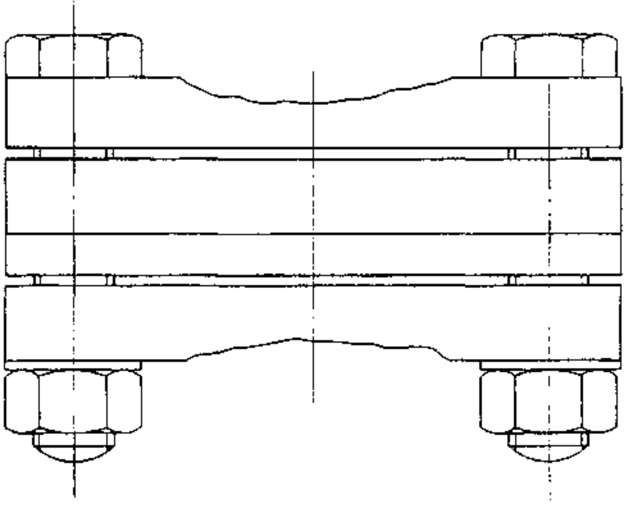


Figure 11 — Full diameter bursting disc holder (in line)

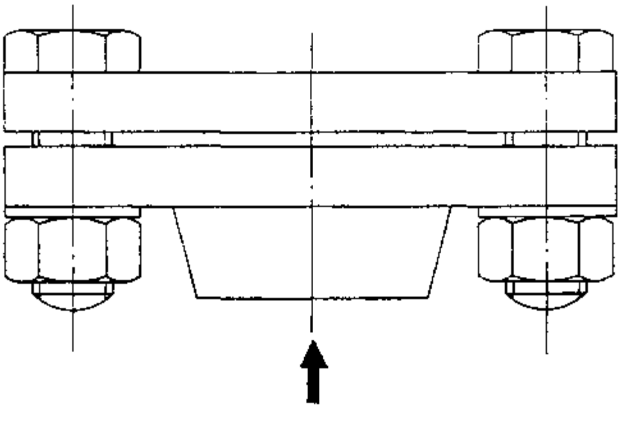


Figure 12 — Full diameter bursting disc holder (end oi line;

2.2.3.3 Union bursting disc holder {see figure 13)

A union bursting disc holder consists of an inlet and an outlet member connected by a union nut. The connection for the inlet may be threaded or welded. The connection for the outlet may be threaded, welded, free-vented or muffled.

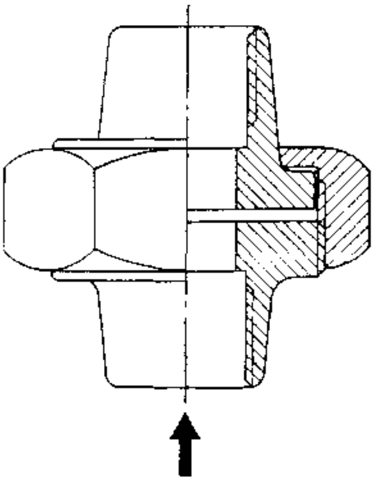


Figure 13 — Union bursting disc holder

2.2.3.4 Plug/screw bursting disc holder (see figure 14)

A plug/screw bursting disc holder consists of two or more parts screwed together and locating a bursting disc. The inlet connection may be welded or threaded. The outlet connection may be welded, threaded, free-vented or muffled.

This type of bursting disc holder is generally suited to small sizes of bursting discs and a wide range of pressures. If installed in pipework, an additional connection may be required to facilitate installation and removal of the bursting disc.

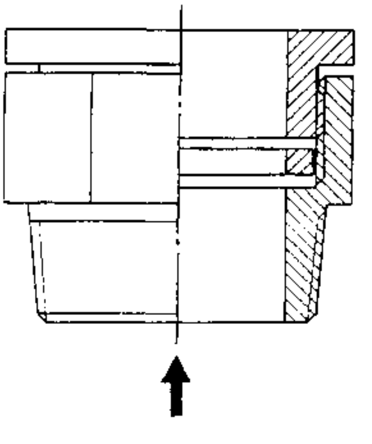


Figure 14 — Plug/screw bursting disc holder

2.2.3.5 Other types of bursting disc holders

Other types of bursting disc holders are allowed provided that they meet the requirements of this International Standard.

2.3 Back pressure supports

2.3.1 General

Where a bursting disc may be subjected in service to a back pressure differential, it shall be fitted with a back pressure support unless the bursting disc itself is strong enough to support the pressure differential. The inclusion of a back pressure support may reduce the discharge capacity and shall be taken into account when selecting the bursting disc size.

The bursting disc and back pressure support shall be supplied by the manufacturer, preferably as an assembly, to ensure that

a) there is a correct fit between the back pressure support and bursting disc to prevent damage to the bursting disc, and

b) the back pressure support is fitted to the correct side of the bursting disc as designed by the manufacturer.

The back pressure support shall be such that the bursting disc assembly is not deformed when subjected to the back pressure specified.

The edges of the slits and/or perforations shall be free from all burrs or similar imperfections that might cause a premature failure.

2.3.2 Opening back pressure supports

The opening type of back pressure support shall fit closely against the bursting disc so as to give support to part of its area. The support shall be slit or perforated to transmit the pressure in the system to the bursting disc.

If there is not adequate discharge capacity through the slits and/or perforations, the back pressure support shall open when subjected to a pressure not exceeding the minimum bursting pressure at the coincident temperature of the associated bursting disc. The support shall open to provide a flow area sufficient to permit the discharge of the contents of the system within the requirements of 1.7.2 when the bursting disc has burst.

2.3.3 Non-opening back pressure supports

The non-opening type of back pressure support shall fit closely against the bursting disc to give support to part of its area. The support shall be perforated with one or more holes to provide a flow area sufficient to permit the discharge of the contents of the system within the requirements of 1.7.2.

2.4 Temperature shields

A temperature shield shall be used to protect a bursting disc fitted with a back pressure support only when specifically recommended by the bursting disc manufacturer.

2.5 Stiffening rings

Fragile bursting discs may be fitted with stiffening rings for easier handling.

2.6 Gaskets

Gaskets used on either side or both sides of a bursting disc shall be compatible with the chemical, thermal and mechanical demands of the application. The use, type, material, thickness and diameter of the gasket shall comply with the bursting disc manufacturer's recommendation

Section 3: Means of protection from corrosion

3.1 General

Bursting disc devices are frequently required to work in corrosive environments. Materials likely to be affected by corrosion may be protected by coating, plating, lining or other suitable means which shall be supplied only by the manufacturer.

3.2 Coatings

Coatings shall be applied by a suitable method to give an even and homogeneous coating to the surfaces to be protected.

3.3 Plating

Plating shall be applied by a suitable method to give an even and homogeneous plating to the surface to be protected,

3.4 Bursting disc linings

The linings, where possible, should be attached to the bursting disc so as to preserve them as a set or integral unit.

Section 4: Inspection and testing

4.1 Inspection

After manufacture, all components of a bursting disc device shall be inspected visually. Any that exhibit defects which may affect the performance of the bursting disc device shall be discarded or such defects shall be rectified.

Bursting discs made from foil less than 0,2 mm thick shall be examined, for example over a suitable light box using an illuminance not less than 5 000 lx, and shall be discarded if they appear porous.

The continuity of coatings, plating and linings shall be checked by suitable means.

NOTE 7 For example, for non-conductive material a suitable method is electro-static testing.

Those discs exhibiting defects that affect the integrity of the bursting disc device shall be discarded or such defects shall be rectified.

4.2 Testing

4.2.1 Burst testing of sample bursting discs

A number of completed bursting discs shall be selected at random from each batch and shall be subjected to testing as specified in 4.2.1.1 or 4.2.1.2.

4.2.1.1 Bursting discs for use at room temperature shall be tested at room temperature. The number tested shall be in accordance with table 1.

4.2.1.2 Bursting discs for use at a temperature other than room temperature shall be tested as agreed between the manufacturer and the purchaser, as specified in the appropriate regulations or standards, or by one of the procedures specified in 4.2.1.2.1 to 4.2.1.2.3.

4.2.1.2.1 At least two sample bursting discs from each batch of bursting discs, manufactured from the same material and of the same size as those to be used, shall be tested at the specified coincident temperature to verify that the bursting pressure fails within the specified performance tolerance or range of minimum and maximum bursting pressure at the coincident temperature.

In addition, the number of bursting discs specified in table 1, minus the number of bursting discs tested at coincident temperature, shall be tested at room temperature, with a minimum of one bursting disc being tested at room temperature.

4.2.1.2.2 For conventional simple domed bursting discs and flat and monobloc graphite bursting discs, pressure/temperature curves may be used for the interpolation of the bursting pressure at coincident temperature. Each pressure/temperature curve is specific to each of those types of bursting discs manufactured from a specific lot of material.

These pressure/temperature curves shall be established as follows.

A sample batch of at least 12 bursting discs shall be tested. The bursting discs shall be tested at each of four different temperatures across the applicable temperature range, with a minimum of three bursting discs at each temperature.

The results of these tests shall be used to establish a curve of bursting pressure versus temperature for that particular batch of material

When this method of testing is used, a quantity of bursting discs in accordance with table 1, from each lot of bursting discs, shall be tested at room temperature to verify that the bursting pressure falls within the specified performance tolerance or range of minimum and maximum bursting pressure at room temperature.

4.2.1.2.3 For all types of bursting discs, pressure/temperature curves may be used for the interpolation of the bursting pressure at coincident temperature. Each pressure/temperature curve established by this method is specific to a particular type of bursting disc, a particular size and a particular lot of material.

These pressure/temperature curves shall be established as follows.

A sample batch of at least 12 bursting discs of a particular type, manufactured from the same lot of material and of the same size as those for which the pressure/temperature curve is being established, shall be tested. The bursting discs from this batch shall be tested at four different temperatures across the applicable temperature range, with a minimum of three bursting discs at each temperature.

The results of these tests shall be used to establish a curve of bursting pressure versus temperature for that particular size, lot of material and type of bursting disc.

Where the test results obtained for at least three different sizes of a particular type of bursting disc, in a particular lot of material, establish that the pressure/temperature curve is the same across the tested size range, then one curve may be used for the interpolation of the bursting pressure at the coincident temperature, within the size range tested.

When this method is used, a quantity of bursting discs in accordance with table 1, from each batch of bursting discs manufactured from the same lot of material and of the same size and type for which the pressure/temperature curves have been established, shall be tested at room temperature to verify that the bursting pressure falls within the specified performance tolerance or range of minimum and maximum bursting pressure at room temperature.

4.2.2 General requirements

4.2.2.1 The sample bursting discs shall be burst in a holder or test die identical in orifice size and orifice configuration with that in which the bursting disc will be installed.

4.2.2.2 In the case of reverse domed bursting discs, the holder shall be connected to a pressure system suitable to achieve bursting disc reversal.

4.2.2.3 A clamping load shall be applied in accordance with the manufacturer's specification.

4.2.2.4 The testing apparatus shall include pressure and temperature measuring equipment.

4.2.2.5 The pressure sensing device shall be located as near as possible to the bursting disc inlet and connected to it in such a way as to minimize pressure drop.

4.2.2.6 With one of the bursting discs installed, increase the pressure at the inlet to 90 % of the expected minimum bursting pressure in a time not less than 5 s. Thereafter, increase the pressure at the device inlet steadily and continuously until the bursting disc bursts or vents. Record the bursting pressure and any other pertinent characteristics.

Some applications may require testing procedures which deviate **from** the above. These shall be as agreed between the purchaser and the manufacturer or as specified in the appropriate regulations or standards.

4.2.2.7 When testing with gas it is particularly important to ensure that the appropriate safety precautions are observed.

4.2.2.8 When required by the appropriate regulations or standards or the user, an independent authority shall witness the test.

Table 1 — Number of bursting discs to be tested

Total number of bursting discs in batch	Number of bursting discs to be tested
Less than 10	2
10 to 15	3
16 to 30	4
31 to 100	6
101 to 250	4 % but not less than 6
251 to 1 000	3 % but not less than 10

NOTES

1 Discarded and test bursting discs are not considered as part of the total number of the batch.

2 For batches above 1 000 the number of bursting discs to be tested shall be agreed between the manufacturer and purchaser.

3 Any agreement to vary the number of bursting discs to be tested shall be based upon appropriate regulations or standards.

Section 5: Marking, identification and packaging

5.1 Marking

5.1.1 Bursting discs

5.1.1.1 Each bursting disc shall be permanently marked (where practicable; see 5.1.1.2 to 5.1.1.4) with the following minimum information:

a) manufacturer's identity;

b) nominal size DN or nominal pipe size NPS, as appropriate;

c) material identity;

d) the maximum and minimum specified bursting pressures and coincident temperature, stating units,

or

the specified bursting pressure and a performance tolerance and a coincident temperature, stating units;

NOTE 8 The range of pressure between the maximum and minimum specified bursting pressures will be equivalent to the performance tolerance.

e) the number of this International Standard;

f) vent side;

g) for monobloc bursting discs only, a direction of flow arrow on the outside diameter;

h) where appropriate, torque loading, number and size of bolts required to clamp;

i) appropriate bursting disc holder identity.

The method of marking shall not impair performance. Where practicable, the bursting disc shall be marked such that the information is visible after installation.

A physical coding system such as pins and slots applied to a holder and bursting disc may be used in addition to the marking on the bursting disc. The holder for such a combination shall be permanently marked with all information plus the code reference available.

5.1.1.2 If bursting discs cannot be marked with the information specified in 5.1.1.1, this information shall be permanently marked on a tag or label attached to the bursting disc such that (where practicable) it is visible after installation.

5.1.1.3 Where the physical size of the bursting disc is so small that it can only bear the vent side identification mark, a suitable individual package bearing the other markings required by 5.1.1.1 shall be used to contain the bursting disc until it is mounted. A tag bearing the same markings should be included in the package.

5.1.1.4 Where identification marks cannot be seen when the bursting disc assembly is installed in the system, the purchaser shall be responsible for attaching to the installation a suitable tag which shall be permanently marked with the same information as placed on the bursting disc or in the package.

5.1.2 Bursting disc holder

Each bursting disc holder shall be permanently marked on the outside diameter with the following minimum information;

a) manufacturer's identity;

b) bursting disc holder identity;

c) nominal size DN or nominal pipe size NPS, as appropriate;

d) material identity;

e) direction of flow arrow;

f) the number of this International Standard

5.1.3 Ancillary components

Ancillary components, such as temperature shields, which may be supplied separately from a bursting disc assembly, when appropriate, shall be marked to indicate the direction of flow.

5.2 Packaging

Bursting disc devices or their components shall be packed to prevent any damage which may impair performance.

Each container shall be permanently marked with the following minimum information:

a) manufacturer's identity;

b) nominal size DN or nominal pipe size NPS, as appropriate;

c) material identity;

d) the maximum and minimum specified bursting pressures and coincident temperature, stating units,

or

the specified bursting pressure and a performance tolerance and a coincident temperature, stating units;

e) the number of this International Standard;

f) (he bursting disc holder identity, where appropriate.

If required by the purchaser, installation and assembly instructions shall be provided by the manufacturer

Where components of the bursting disc assembly, for example back pressure supports, are to be supplied separately then the containers shall be marked with the appropriate cross-reference.

Section 6: Certification

6.1 Test certificates

If specified by the purchaser, the manufacturer shall provide for each batch, or part of batch, a test certificate stating that the bursting discs have been manufactured and tested in accordance with the requirements of this International Standard, and giving the following minimum information:

a) nominal size DN or nominal pipe size NPS, as appropriate;

b) the maximum and minimum specified bursting pressures and coincident temperature as specified by the purchaser for the application,

or

the specified bursting pressure and a performance tolerance and a coincident temperature;

c) information as in b) correlated to the conditions of the test;

d) any further information regarding bursting pressure/temperature, if requested by the purchaser,

e) the actual bursting pressures and temperatures recorded when the bursting discs under test were burst;

0 the material(s) of the bursting disc and components supplied;

g) name of the manufacturer;

h) manufacturer's identification mark;

i) inspection authority identification (where appropriate);

j) batch identification;

k) the number of this International Standard;

I) endorsement that the tests reported have been carried out;

m) where testing is required by an appropriate regulation or standard, or as agreed between the manufacturer and the purchaser, the bursting disc device discharge area established by the test, stating units.

6.2 Additional information

If specified by the purchaser, where the bursting disc device discharge area has been determined other than by testing on the batch or part batch (see 1.7.1), the bursting disc device discharge area should be provided to the purchaser, stating the units and the method by which it was established.

Annex A
(informative)

Discharge capacity

A.1 General

A.1.1 This annex gives some guidance on the determination of the mass flow rate of a discharge system that contains a bursting disc device. It relates only to single-phase flow.

NOTE 9 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 flashes to vapour on venting, are being considered for inclusion in a future revision of this International Standard.

A.1.2 Two methods are given as follows.

a) The first method gives a simplified approach, neglecting pressure drops in the inlet pipe and in the discharge pipe. Therefore this method is of limited application.

b) The second method relates to discharge systems where consideration needs to be given to the changes in pressure throughout the discharge system.

A.1.3 It is important to ensure that the method selected is appropriate to the particular application and is correctly applied by appropriately qualified and experienced persons.

A.1.4 Values of pressure loss (resistance coefficients) and coefficients of discharge of the bursting disc device may be governed by appropriate regulations or standards.

A.1.5 This discharge rate of the discharge system should be such as to ensure that under relieving conditions the maximum allowable working pressure of the pressurized system to be protected is not exceeded by more than 10 % of the maximum allowable working pressure, or as governed by the appropriate regulations or standards.

A.2 Method 1

A.2.1 General

This method should be used where it can be safely assumed that there are only negligible pressure drops in the inlet pipe or the discharge pipe.

In such cases the following applies:

a) for compressible fluids the flow rate is controlled by the nozzle entry configuration of the equipment and the bursting disc device;

b) for incompressible fluids a discharge coefficient of 0,62 is used.

The values of the combined coefficient given in table A.1 for the nozzle entry configuration and the bursting disc device to be used for compressible fluids are based on experimental work carried out at the University (RWTH) of Aachen and reported in [1].

The limitations of the applications for compressible fluids and incompressible fluids are given in A.2.2 and A.2.3 respectively.

A.2.2 Compressible fluids

The use of this method is limited to those applications where

a) the bursting disc device is installed within eight pipe diameters from the entry to the equipment nozzle,

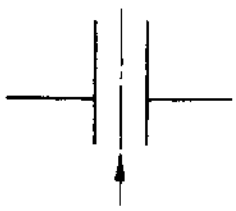
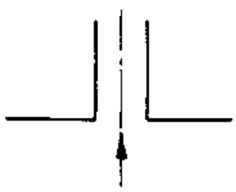
b) the bursting disc device discharge area is not less than 50 % of the inlet pipe area,

c) the nozzle configurations are as illustrated in table A.1,

d) the flow is single phase, and

e) the length of the discharge pipe following the bursting disc device does not exceed five pipe diameters.

Table A.1 — Discharge coefficients a

No.	Nozzle type		Discharge coefficient a (compressible fluids)
1		Protruding nozzle	0,68
2		Set-on or set-in nozzle and also a block flange whose design is not of hydrodynamic configuration	0,73
3		Block flange of hydrodynamic configuration, e.g. with rounded or chamfered inlet edges, and also with a necked-out opening	0,80

A.2.2.1 Critical and subcritical flow

The flow rate of a compressible fluid through a bursting disc 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 in the flow rate.

Critical flow occurs when

$$\frac{p_b}{p} < \left(\frac{2}{\kappa + 1}\right)^{\kappa/(\kappa - 1)} \quad \ldots (A.1)$$

and subcritical flow occurs when

$$\frac{p_b}{p} > \left(\frac{2}{\kappa + 1}\right)^{\kappa/(\kappa - 1)} \quad \ldots (A.2)$$

where

p_b is the back pressure immediately downstream of the smallest cross-sectional flow area, in bar[1] absolute;

κ is the isentropic exponent of the gas or vapour in the pressure system at the relieving inlet conditions;

p is the relieving pressure, in bar absolute.

A.2.2.2 Discharge capacity at critical flow

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

$$q_m = 0{,}288\,3\, C \alpha A_0 \sqrt{\frac{p}{v}} \quad \ldots (A.3)$$

$$A_0 = 3{,}469 \frac{q_m}{C\alpha} \sqrt{\frac{v}{p}} \quad \ldots (A.4)$$

$$q_m = C \alpha A_0 p \sqrt{\frac{M}{TZ}} \quad \ldots (A.5)$$

$$A_0 = \frac{1}{C} \frac{q_m}{\alpha p} \sqrt{\frac{TZ}{M}} \quad \ldots (A.6)$$

where

A_0 is the required minimum cross-sectional flow area of a bursting disc device, in square millimetres;

C is a function of the isentropic exponent κ (for values, see table A.2), where

1) 1 bar ⇒ 10^5 N/m^2 = 100 kPa

$$C = 3,948\sqrt{\kappa\left(\frac{2}{\kappa + 1}\right)^{(\kappa+1)/(\kappa-1)}} \qquad \ldots (A.7)$$

M is the molar mass, in kilograms per kilomole;

p is the relieving pressure, in bar absolute;

q_m is the mass flow rate to be discharged or the required capacity of the bursting disc device, in kilograms per hour;

T is the relieving temperature, in kelvin;

v is the specific volume at the actual relieving pressure and relieving temperature, in cubic metres per kilogram;

Z is the compressibility factor (this may be assessed from figure B.1);

NOTE 10 Table A.3 gives values of critical temperature and pressure for some gases to assist in the determination of Z; however, if insufficient information is available, a value of 1,0 may be used. (See also annex B.)

a is the discharge coefficient of the nozzle type and the bursting disc device combined as per A.2.2.3.

Table A.2 — Values of C relative to values of κ

κ	C	κ	C	κ	C
0,40	1,65	1,02	2,41	1,42	2,72
0,45	1,73	1,04	2,43	1,44	2,73
0,50	1,81	1,06	2,45	1,46	2,74
0,55	1,89	1,08	2,46	1,48	2,76
0,60	1,96	1,10	2,48	1,50	2,77
0,65	2,02	1,12	2,50	1,52	2,78
0,70	2,08	1,14	2,51	1,54	2,79
0,75	2,14	1,16	2,53	1,56	2,80
0,80	2,20	1,18	2,55	1,58	2,82
0,82	2,22	1,20	2,56	1,60	2,83
0,84	2,24	1,22	2,58	1,62	2,84
0,86	2,26	1,24	2,59	1,64	2,85
0,88	2,28	1,26	2,61	1,66	2,86
0,90	2,30	1,28	2,62	1,68	2,87
0,92	2,32	1,30	2,63	1,70	2,89
0,94	2,34	1,32	2,65	1,80	2,94
0,96	2,36	1,34	2,66	1,90	2,99
0,98	2,38	1,36	2,68	2,00	3,04
0,99	2,39	1,38	2,69	2,10	3,09
1,001	2,40	1,40	2,70	2,20	3,13

A.2.2.3 Discharge coefficient at critical flow

A.2.2.3.1 The discharge coefficients for three specific types of nozzle and bursting disc device combinations are listed in table A.1.

These discharge coefficients are valid where

$$0,5A_1 \leqslant A_0 \leqslant A_1$$

where

A_0 is the required minimum cross-sectional flow area of the bursting disc device, in square millimetres;

A_1 is **the** cross-sectional area of the inlet pipe, in square millimetres.

A.2.2.3.2 Where required by appropriate regulations or standards, or where the nozzle —disc configuration **is** different from those shown in table A.1, tests may be required.

The experimentally established discharge coefficient shall be multiplied by 0,9 before application in formulae (A.3) to (A.6). The given discharge area, however, can be applied without any correction.

A.2.2.4 Discharge capacity at subcritical flow

The discharge capacity at subcritical flow can be obtained from one of the following equations:

$$q_m = 0,288\,3CK_b\alpha A_0\sqrt{\frac{p}{v}} \qquad \ldots (A.8)$$

$$A_0 = 3,469\frac{q_m}{CK_b\alpha}\sqrt{\frac{v}{p}} \qquad \ldots (A.9)$$

$$q_m = CK_b\alpha A_0 p\sqrt{\frac{M}{TZ}} \qquad \ldots (A.10)$$

$$A_0 = \frac{1}{CK_b}\frac{q_m}{\alpha p}\sqrt{\frac{TZ}{M}} \qquad \ldots (A.11)$$

where

A_0 is the required minimum cross-sectional flow area of a bursting disc device, in square millimetres;

C is a function of the isentropic coefficient κ (for values, see table A.2);

K_b is a factor which corrects for the reduction in capacity due to the increase in back pressure (see table A.4), where

$$K_b = \sqrt{\frac{\frac{2\kappa}{\kappa - 1}\left[\left(\frac{p_b}{p}\right)^{2/\kappa} - \left(\frac{p_b}{p}\right)^{(\kappa+1)/\kappa}\right]}{\kappa\left(\frac{2}{\kappa+1}\right)^{(\kappa+1)/(\kappa-1)}}} \qquad \ldots (A.12)$$

NOTE 11 For critical flow, $K_b = 1,0$.

M is the molar mass, in kilograms per kilomole;

p is the relieving pressure, in bar absolute:

p_b is the back pressure immediately downstream of the smallest cross-sectional flow area, in bar absolute;

q_m is the mass flow rate to be discharged or the required capacity of a bursting disc device, in kilograms per hour;

T is the relieving temperature, in kelvin;

v is the specific volume at the actual relieving pressure and relieving temperature, in cubic metres per kilogram;

Z is the compressibility factor (this may be assessed from figure B.1);

NOTE 12 Table A.3 gives values of critical temperature and pressure for some gases to assist in the determination of Z; however, if insufficient information is available, a value of 1,0 may be used. (See also annex B.)

a is the discharge coefficient of the nozzle type and the bursting disc device combined as per A.2.2.3.

Table A.3 — Properties of gases

Gas	Symbol or formula	Molar mass, M kg/kmol	Ratio of specific heat capacities $\kappa = \gamma = C_p/C_v$ (1,013 bar absolute; 15 °C)	Critical pressure, p_c bar absolute	Critical temperature, T_c K	Critical pressure ratio
Acetylene	C_2H_2	26,04	1,26	62,82	309,15	0,553
Air	—	28,97	1,40	37,69	132,45	0,528
Ammonia	NH_3	17,03	1,31	112,98	405,55	0,544
Argon	Ar or A	39,95	1,66	48,64	151,15	0,488
Butadiene	C_4H_6	54,09	1,113	43,27	425	0,581
n-Butane	C_4H_{10}	58,12	1,11	36,48	426,15	0,583
Carbon dioxide	CO_2	44,01	1,30	73,97	304,25	0,546
Carbon monoxide	CO	28,01	1,40	35,46	134,15	0,528
Chlorine	Cl_2	70,91	1,35	77,11	417,15	0,537
Chlorodifluoromethane (R 22)	$CHClF_2$	86,47	1,18	49,14	370,15	0,568
Dichlorodifluoromethane (R 12)	CCl_2F_2	120,91	1,139	40,08	384,65	0,577
Ethane	C_2H_6	30,05	1,22	49,45	305,25	0,561
Ethylene	C_2H_4	28,05	1,25	51,57	282,85	0,555
Hydrogen	H_2	2,02	1,41	12,97	33,25	0,527
Hydrogen chloride	HCl	36,46	1,41	82,68	324,55	0,527
Hydrogen sulfide	H_2S	34,08	1,32	90,08	373,55	0,542
Isobutane	$CH(CH_3)_3$	58,12	1,11	37,49	407,15	0,583
Methane	CH_4	16,04	1,31	46,41	190,65	0,544
Methyl chloride	CH_3Cl	50,49	1,28	66,67	416,25	0,549
Nitrogen	N_2	28,01	1,40	33,94	126,05	0,528
Nitrous oxide	N_2O	44,01	1,30	72,65	309,65	0,546
Oxygen	O_2	32,00	1,40	50,36	154,35	0,528
n-Propane	C_3H_8	44,10	1,13	43,57	368,75	0,579
Propylene	C_3H_6	42,08	1,15	45,60	365,45	0,574
Sulfur dioxide	SO_2	64,06	1,29	78,73	430,35	0,548

NOTE — The principal sources on which these data are based are [2], [3] and [4].

Table A.4 — Capacity correction factors for back pressure, K_b

$\frac{p_b}{p}$	Isentropic exponent, κ																		
	0,4	0,5	0,6	0,7	0,8	0,9	1,001	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2,0	2,1	2,2
	Capacity correction factor for back pressure, K_b																		
0,45																	1,000	0,999	0,999
0,50												1,000	1,000	0,999	0,999	0,996	0,994	0,992	0,989
0,55									0,999	1,000	0,999	0,997	0,994	0,991	0,987	0,983	0,979	0,975	0,971
0,60							1,000	0,999	0,997	0,993	0,989	0,983	0,978	0,972	0,967	0,961	0,955	0,950	0,945
0,65						0,999	0,995	0,989	0,982	0,974	0,967	0,959	0,951	0,944	0,936	0,929	0,922	0,915	0,909
0,70			0,999	0,999	0,993	0,985	0,975	0,964	0,953	0,943	0,932	0,922	0,913	0,903	0,895	0,886	0,879	0,871	0,854
0,75		1,000	0,995	0,983	0,968	0,953	0,938	0,923	0,909	0,896	0,884	0,872	0,861	0,851	0,841	0,832	0,824	0,815	0,808
0,80	0,999	0,985	0,965	0,942	0,921	0,900	0,881	0,864	0,847	0,833	0,819	0,806	0,794	0,783	0,773	0,764	0,755	0,747	0,739
0,82	0,992	0,970	0,944	0,918	0,894	0,872	0,852	0,833	0,817	0,801	0,787	0,774	0,753	0,752	0,741	0,732	0,723	0,715	0,707
0,84	0,979	0,948	0,917	0,888	0,862	0,839	0,818	0,799	0,782	0,766	0,752	0,739	0,727	0,716	0,706	0,697	0,688	0,680	0,672
0,86	0,957	0,919	0,884	0,852	0,800	0,779	0,759	0,742	0,727	0,712	0,700	0,688	0,677	0,667	0,667	0,658	0,649	0,641	0,634
0,88	0,924	0,881	0,842	0,809	0,780	0,755	0,733	0,714	0,697	0,682	0,668	0,655	0,644	0,633	0,624	0,615	0,606	0,599	0,592
0,90	0,880	0,831	0,791	0,757	0,728	0,703	0,681	0,662	0,645	0,631	0,617	0,605	0,594	0,584	0,575	0,566	0,558	0,551	0,544
0,92	0,820	0,769	0,727	0,693	0,664	0,640	0,619	0,601	0,585	0,571	0,559	0,547	0,537	0,527	0,519	0,511	0,504	0,497	0,490
0,94	0,739	0,687	0,647	0,614	0,587	0,565	0,545	0,528	0,514	0,501	0,489	0,479	0,470	0,461	0,453	0,446	0,440	0,434	0,428
0,96	0,628	0,579	0,542	0,513	0,489	0,469	0,452	0,438	0,425	0,414	0,404	0,395	0,387	0,380	0,373	0,367	0,362	0,357	0,352
0,98	0,426	0,422	0,393	0,371	0,353	0,337	0,325	0,314	0,305	0,296	0,289	0,282	0,277	0,271	0,268	0,262	0,258	0,254	0,251
1,00	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000

A.2.2.5 Discharge coefficient at subcritical flow

In the case of subcritica! flow conditions, the discharge coefficients caused by flow restrictions approximate with increasing pressure ratio *fojp* to those which have been demonstrated for incompressible fluids.

A.2.3 Incompressible fluids

A.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 equation applies:

$$q_m = 1{,}610 A_0 f_\mu \alpha \sqrt{\Delta p \rho} \qquad \ldots (A.13)$$

which may be rewritten as

$$A_0 = 0{,}621\,1 \frac{q_m}{f_\mu \alpha \sqrt{\Delta p \rho}} \qquad \ldots (A.14)$$

where

- A_o is the required minimum cross-sectional flow area of a bursting disc device, in square millimetres;
- f_M is a correction factor for liquid viscosity. Where the liquid has a viscosity less than or equal to that of water at 20 °C, this factor may be taken as 1,0. For greater viscosities, the discharge through a given bursting disc device will be reduced.

  The factor f^ is related to the Reynolds number and can be obtained from figure A.1. Reynolds number *Re* may be established from the equation

  $$Re = 0{,}313\,4 \frac{q_m}{\mu \sqrt{A_0}}$$

  where д is the liquid dynamic viscosity, in pascal second[1];
- *Ap* is the pressure difference on venting between the pressure system and the pressure at the end of the discharge system/the atmosphere, in bar;

  NOTE 13 The effect of static head should be considered.
- q_m is the mass flow rate to be discharged, in kilograms per hour;
- *a* is the discharge coefficient of the nozzle type, as per A.2.3.2;
- *p* is the density, in • kilograms per cubic metre.

When sizing for viscous relief, first establish what the size would be for non-viscous service to obtain a preliminary area. Then select the next largest size in calculating *Re.* If the sizing formula shows that the area assumed in calulating *Re* was too small, then repeat the calculation with the next largest size of bursting disc device.

A.2.3.2 Discharge coefficient

The discharge coefficient *a* is equal to 0,62 or as established in the appropriate regulations or standards.

A.2.4 Selection of the bursting disc device

The actual cross-sectional flow area $/f_B$ of a bursting disc device shall be not less than the required minimum cross-sectional flow area $/f_0$ calculated, where A_B, which is also the discharge area after bursting or venting, is in square millimetres.

When the cross-sectional flow area of a bursting disc device being selected exceeds the inlet pipe flow area A_u then /f, instead of A_B is the controlling cross-sectional flow area.

A.3 Method 2

A.3.1 General

A.3.1.1 This method takes into consideration the reversible and the irreversible changes in pressure throughout the discharge system (e.g. nozzle entry, inlet pipe, bursting disc device, discharge pipe, exit to a downstream vessel or to the atmosphere).

A.3.1.2 For the analysis of the discharge system the following information relating to the bursting disc device is required:

a) the pressure loss (resistance coefficient) after bursting or venting;

b) the discharge area after bursting or venting.

A.3.2 Compressible fluids

Establish whether the flow is subcritical or critical.

A.3.2.1 Subcritical flow

In the case of subcritical flow, assume a flow rate and calculate the changes in pressure through the discharge system. Use an iterative procedure until

2) 1 Pa-s - 1 kg/(nvs)

the flow rate, for which the calculated pressure drop is equal to or less than the pressure difference available, is found.

A.3.2.2 Critical flow

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

The recommended method of carrying out the analysis is as follows.

a) Determine the possible choke locations, starting at the entry to the equipment nozzle.

b) Assume a flow rate and then calculate the changes in pressure throughout the discharge 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.

Use an iterative procedure 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. Such basic equations are given in, for example, (51.

A.3.3 Incompressible fluids

Establish whether the flow is independent of the Reynolds number or dependent on the Reynolds number.

A.3.3.1 Flow independent of the Reynolds number

In the case where the flow is independent of the Reynolds number (complete turbulence), the flow rate may be determined directly by using basic fluid flow formulae.

A.3.3.2 Flow dependent on the Reynolds number

In the case where flow is dependent on the Reynolds number, assume a flow rate and calculate the changes in pressure through the discharge system. Use an iterative procedure until the flow rate, for which the calculated pressure drop is equal to or less than the pressure difference available, is found.

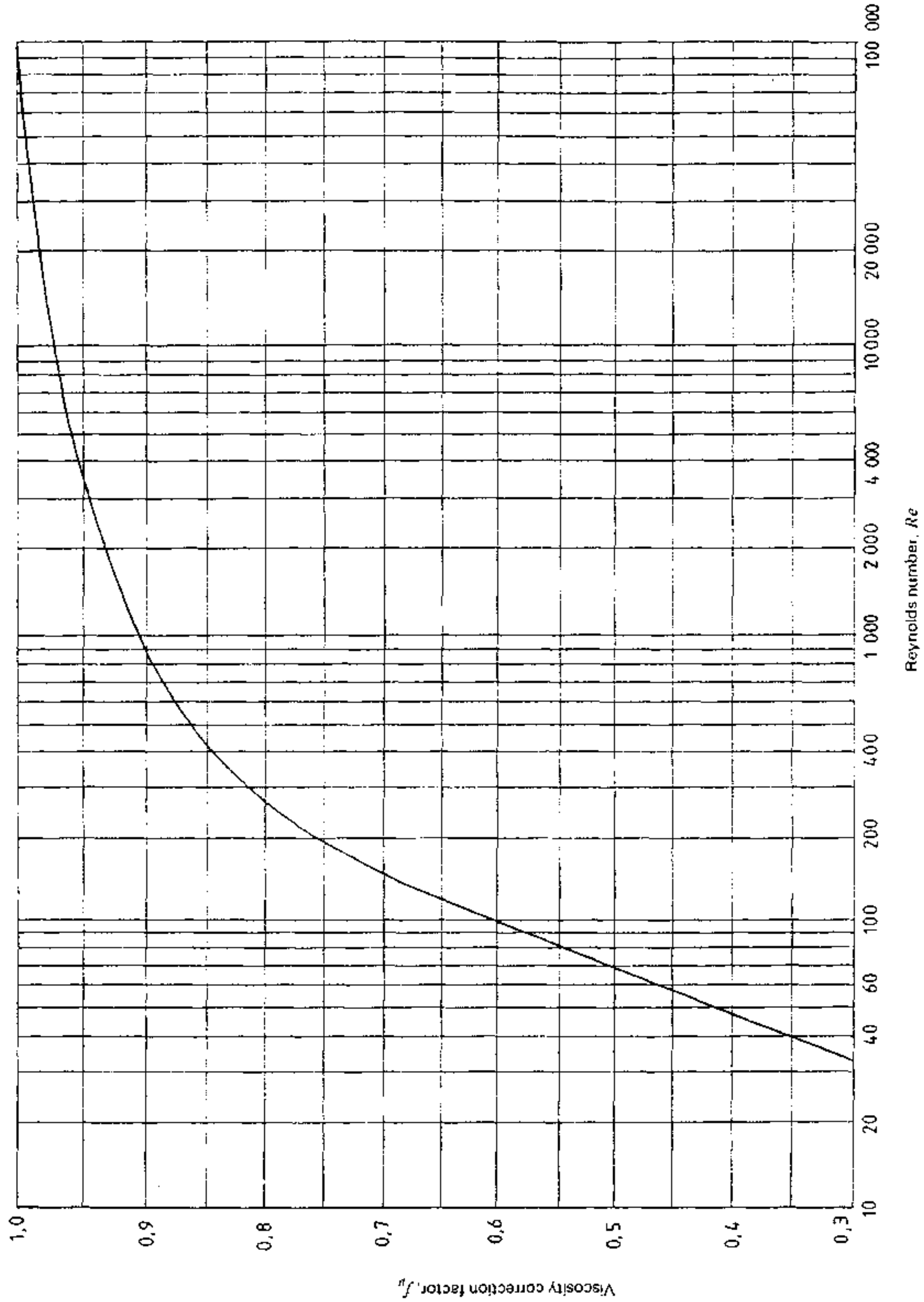


Figure A.1 — Correction factors for liquid dynamic viscosity

Annex B
(informative)

Derivation of compressibility factor Z

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

$$Z = 10^5 pvM/RT$$

where

- M is the molar mass of the gas, in kilograms per kilomole;
- p is the relieving pressure, in bar absolute;
- R is the universal gas constant [= 8 314 J/(kmol·K)];
- T is the relieving temperature, in kelvin;
- v is the specific volume at the actual relieving pressure and relieving temperature, in cubic metres per kilogram.

In the absence of accurate data, the compressibility factor may be obtained from the reduced temperature $T_r = T/T_c$ and the reduced pressure $p_r = p/p_c$ of the gas from figure B.1, T_c and p_c being the critical temperature and pressure of the pure gas.

EXAMPLE

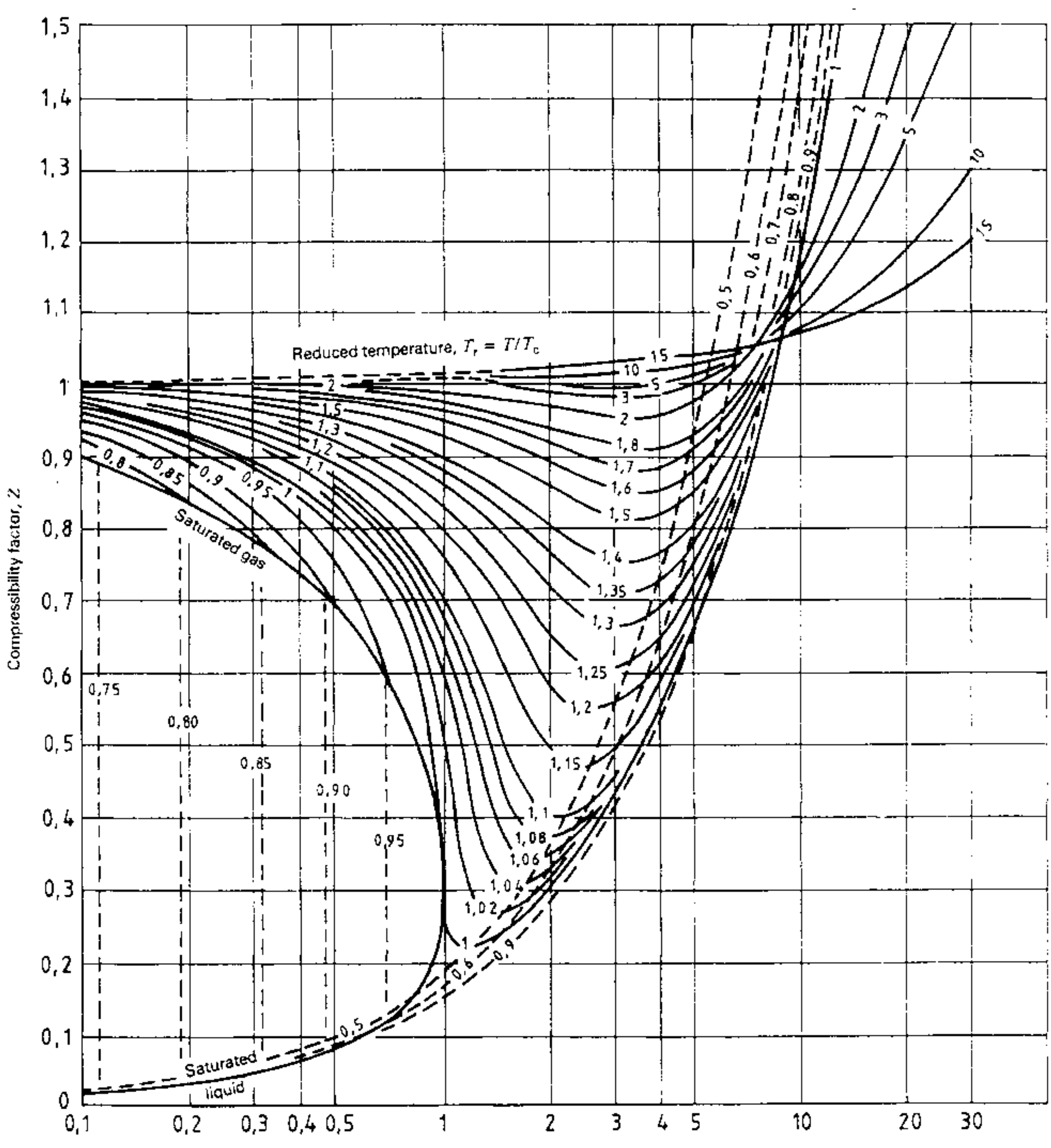
The value of Z for a gas relieving through a bursting disc device with a pressure of 100 bar gauge and a temperature of 70 °C is determined as follows.

Relieving pressure p (in bar absolute)	= 100 + 1 = 101
Relieving temperature T (in kelvin)	= 70 + 273 = 343
Critical pressure p_c	= 50,5 bar absolute
Critical temperature T_c	= 298 K

$$p_r = \frac{p}{p_c} = \frac{101}{50,5} = 2$$

$$T_r = \frac{T}{T_c} = \frac{343}{298} = 1,15$$

From figure B.1, $Z = 0,5$.



Reduced pressure, $p_r = p / p_z$

p is the relieving pressure, in bar absolute;

p_z is the critical pressure, in bar absolute;

T is the relieving temperature, in kelvin;

T_c is the critical temperature, in kelvin.

Figure B.1 — Compressibility factor Z as a function of reduced pressure and reduced temperature

Annex C
(informative)

Typical outline of subjects for inclusion in a quality assurance system

This annex gives general guidance for a manufacturer's quality system that covers design, manufacture, inspection, testing, marking and packaging.

C.1 Scope of work

The written description of the quality system should include the scope and locations of the work to which the system is applicable.

C.2 Authority and responsibility

The authority and responsibility of the management representative in charge of the quality system should be clearly established.

C.3 Organization

An organization chart showing the relationship between management and engineering, purchasing, manufacturing, inspection and quality control, should be prepared.

NOTE 14 The purpose of this chart is to identify and associate the various organizational groups with the particular functions for which they are responsible. These requirements are not intended to encroach on the manufacturer's right lo establish and, from time to time, to alter whatever form of organization the manufacturer considers appropriate for his work.

Persons performing quality control functions should have well-defined responsibility, and the authority and the organizational freedom to identify quality control problems and to initiate, recommend and provide solutions.

C.4 Review of the quality system

The manufacturer should ensure and demonstrate the continuous effectiveness of his quality system.

C.5 Design control

The manufacturer should establish procedures for controlling and verifying the design of the product in order to ensure that the specified requirements are met. The design and design verification should be assigned to qualified personnel having well-defined responsibility. The design should conform to appropriate regulations and national standards and should identify those design characteristics that are crucial to the safe and proper functioning of the bursting disc devices.

C.6 Document control

The manufacturer's quality system should provide procedures which will ensure that the latest applicable documentation, including all authorized changes, is used for manufacture, inspection, testing, marking and packaging.

C.7 Purchase control

The manufacturer should ensure that all purchased materials and services conform to specified requirements and that all purchase orders give full details of the material and services ordered.

C.8 Material control

The manufacturer should include a system of receiving control which ensures that the material received is properly identified and lhat any required documentation is present, identified to the material, and verifies compliance with the specified requirements. The material control system should ensure that only the intended material is used in manufacture. The manufacturer should maintain control of material during the manufacturing process by a system which identifies inspection status of material throughout all stages of manufacture.

C.9 Manufacturing control

The manufacturer should ensure that manufacturing operations are carried out under controlled conditions utilizing documented work instructions. The manufacturer should provide for inspection, where appropriate, for each operation that affects quality, or should arrange an appropriate monitoring operation.

C.10 Quality control plan

The manufacturer's quality control plan should describe the manufacturing operations, including inspections as indicated in this International Standard.

C.11 Welding

The quality control system should include provisions for ensuring that welding conforms to specified requirements. Welders should be qualified to the appropriate standards and their qualification records should be made available to the inspection authority if requested.

C.12 Non-destructive examination

Provision should be made to utilize non-destructive examination as necessary to ensure that materials and components comply with the specified requirements. Non-destructive examination operators should be authorized by their employer and/or qualified by a national recognized body, and their authorizations/qualification records should be made available to the inspection authority if required.

C.13 Non-conforming materials/items

The manufacturer should establish procedures for controlling materials/items not in conformance with the specified requirements

C.14 Heat treatment

The manufacturer should maintain a system to ensure that all required heat treatments have been applied. Means should be provided by which heat treatment requirements can be verified.

C.15 Inspection status

The manufacturer should maintain a system for identifying the inspection status of material during all stages of manufacture and should be able to distinguish between inspected and non-inspected material.

C.16 Calibration of measurement and test equipment

The manufacturer should provide, control, calibrate and maintain inspection, measuring and test equipment to be used in verifying conformance to the specified requirements. Such calibration should be traceable to a national standard and calibration records should be maintained.

C.17 Completed item inspection and test

The manufacturer should perform all inspections and tests on the finished product necessary to complete the evidence of full conformance to the specified requirements.

Procedures for final inspection and test should ensure that all relevant inspection and testing, specified for quality control, have been carried out

C.18 Marking and packaging

The manufacturer should have a system lo control marking and packaging to the extent necessary to ensure conformance with the specified requirements.

C.19 Records retention

The manufacturer should have a system for (he maintenance of inspection records, radiographs and manufacturer's data reports that describe the achievement of the required quality and the effective operation of the quality system. The records should be retained for a minimum period of 5 years or as agreed with the purchaser.

C.20 Sample forms

The forms used in the quality control system and any detailed procedures for their use should be available for review. The written description should make reference to these forms.

Annex D
(informative)

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