BS EN 764-7:2002
Incorporating corrigenda nos. 1 and 2

Pressure equipment —

Part 7: Safety systems for unfired pressure vessels

The European Standard EN 764-7:2002 has the status of a British Standard

ICS 23.020.30

British Standards

National foreword

This British Standard is the UK implementation of EN 764-7:2002, incorporating corrigenda September 2004 and June 2006.

When the reference to this European Standard has been published in the *Official Journal of the European Communities* (OJ), compliance with it will confer a presumption of conformity with the essential requirements covered by the standard in respect of the Pressure Equipment Directive (97/23/EC).

The UK participation in its preparation was entrusted by Technical Committee PVE/1, Pressure vessels, to Subcommittee PVE/1/19, Safety systems.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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This European Standard was approved by CEN on 29 April 2002.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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Contents

Foreword

This document EN 764-7:2002 has been prepared by Technical Committee CEN/TC 54 “Unfired pressure vessels”, the secretariat of which is held by BSI with support of Technical Committee CEN/TC 267 “Industrial piping”.

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 November 2002, and conflicting national standards shall be withdrawn at the latest by November 2002.

This document has been prepared under a mandate given to CEN by the European Commission (EC) and the European Free Trade Association, and supports the essential safety requirements of the Pressure Equipment Directive (PED) 97/23/EC.

For the relationship with the EU Directive(s) see the informative annex ZA which is an integral part of this document.

This European Standard consists of the following parts:

Part 1: Definitions of pressure, temperature and volume.

Part 2: Quantities, symbols and units.

Part 3: Definition of parties involved.

Part 4: Establishment of technical delivery conditions for metallic materials.

Part 5: Inspection documentation of metallic materials and compliance with the material specification.

Part 6: Operating instructions.

Part 7: Safety systems for unfired pressure equipment.

Annexes A, C, E of this European Standard are informative. Annexes B and D are normative.

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, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

A safety system can be the ultimate limitation to protect pressure equipment from exceeding its allowable limits or a means to prevent a potentially hazardous situation leading to injury. These limits consist of permissible pressure, temperature, level, flow or a combination of these which were fixed at the design stage. Regular control and/or monitoring devices which are not a necessary part of a safety systems are excluded from this standard since they become active in advance of a safety system (see Figure 1).

It is essential to consider not only the pressure relieving device or safety related measurement, control and regulation system (SRMCR) but the whole of the pressure relief system so as not to reduce the relieving capacity or adversely effect the proper operation of the pressure relieving devices. Operating problems frequently occur in pressure relief systems because of incorrect selection of the appropriate device or because a correctly selected device was adversely affected by improper handling, incorrect installation or lack of maintenance.

In some cases it can be necessary to establish the basic details of the safety system before selecting the value of the maximum allowable pressure *PS* for the equipment to be protected. Some safety systems need a usual margin between the maximum operating pressure and their reseating pressure which has to be considered before selecting *PS*.

NOTE The role of harmonized standards in supporting the essential safety requirements of European Directives is described in the "Guide to the implementation of directives based on the New Approach and the Global Approach". It can be necessary for products to meet the requirements of more than one directive and it is the responsibility of the manufacturer to ensure that these requirements are complied with. Annex ZA draws attention to the essential safety requirements of EU Directive 97/23/EC "Pressure Equipment Directive" addressed by this standard. This standard also draws attention to subjects which are not covered in detail but are relevant to safety systems.

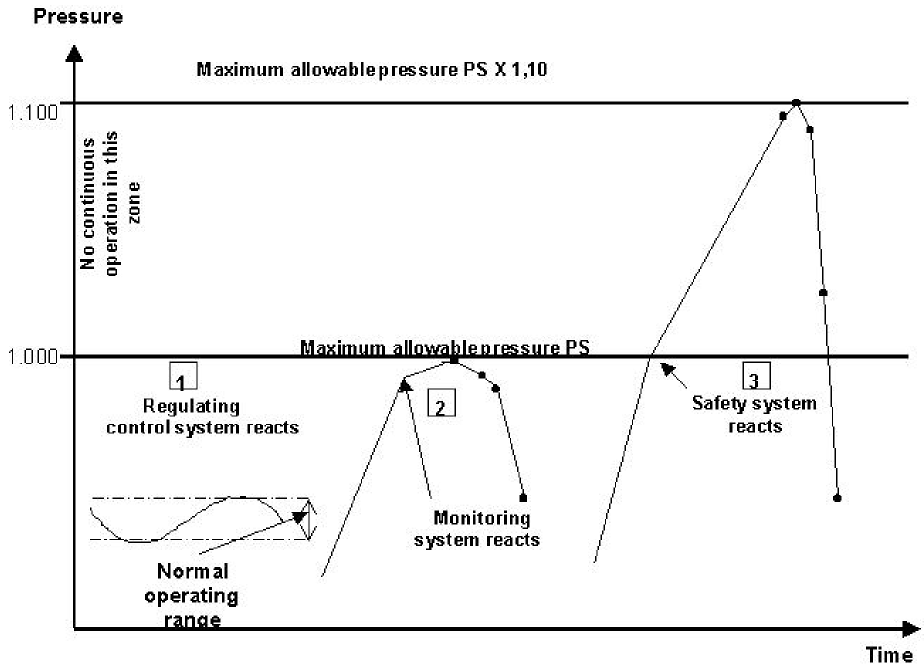


Figure 1 — Response of regulating, monitoring and safety systems in relation to PS

1 Scope

This European Standard specifies the requirements for safety systems which protect a vessel, a system of vessels, piping, accessories or assemblies from exceeding operating conditions.

It is also applicable to safety related indicators and alarms, signals and warning devices when used in safety systems.

Equipment connected together by piping of adequate capacity, free from potential blockages and which does not contain any valve that can isolate any part from the safety system may be considered as a single pressure system when considering the requirements for overpressure protection.

Safety systems include the interconnections between the equipment to be protected and any discharge location. This location can either be an outlet to atmosphere or the entry into a closed disposal system.

NOTE The scope of this standard and its relationship to the safety accessories and other protective devices described in the Pressure Equipment Directive are shown in annex E.

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).

prEN ISO 4126-1, *Safety devices for protection against excessive pressure - Part 1: Safety valves (ISO/DIS 4126-1:1999).*

prEN ISO 4126-2, *Safety devices for protection against excessive pressure - Part 2: Bursting disc safety devices (ISO/DIS 4126-2:1998).*

prEN ISO 4126-3, *Safety devices for protection against excessive pressure - Part 3: Safety valves and bursting discs safety devices in combination (ISO/DIS 4126-3:1999).*

prEN ISO 4126-4, *Safety devices for protection against excessive pressure - Part 4: Pilot operated safety valves (ISO/DIS 4126-4:1999).*

prEN ISO 4126-5, *Safety devices for protection against excessive pressure - Part 5: Controlled Safety Pressure Relief Systems (CSPRS) (ISO/DIS 4126-5:1999).*

prEN ISO 4126-6, *Safety devices for protection against excessive pressure - Part 6: Application, selection and installation of bursting disc safety devices (ISO/DIS 4126-6:2000).*

prEN ISO 4126-7, *Safety devices for protection against excessive pressure - Part 7: Common data (ISO/DIS 4126-7:2000).*

EN 954-1:1998, *Safety of machinery – safety related parts of control systems – Part 1: General principles for design.*

prEN 50156-1, *Electrical equipment for furnaces and ancillary equipment - Part 1: Requirements for application design and installation.*

EN 60529:1991, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989).*

IEC 61508, *Functional safety of electrical/electronic/programmable electronic safety – related systems.*

EN 837-1, *Pressure gauges – Part 1: Bourdon tube pressure gauges – Dimensions, metrology, requirements and testing.*

EN 837-3, *Pressure gauges – Part 3: Diaphragm and capsule pressure gauges – Dimensions, metrology, requirements and testing.*

3 Terms and definitions

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

3.1
safety accessory
device designed and used to protect pressure equipment against the allowable limits being exceeded (see annex E)

3.2
safety system
system of safety accessories and other protective devices which prevents the process parameters exceeding the ultimate limiting values determined by the hazard analysis and ensures that the following risks are eliminated or properly controlled:

— injury to personnel;

— damage to the environment;

— damage to property

3.3
monitoring system
system which periodically checks given parameters and draws attention to those which are outside normal operating limits but which are below the limiting values determined by the hazard analysis. Normal operating conditions of the process can be restored either directly by the system or by an operator

3.4
regulating system
system which adjusts or controls a particular parameter to maintain operation within predetermined limits

3.5
independence
ability to function as required without interference from or dependence upon other equipment

3.6
fail-safe
characteristic whereby the failure of any safety system or any energy source will leave the protected equipment in a safe condition

3.7
hazard
potential source of harm

[ISO/IEC Guide 51:1999]

NOTE 1 Harm is the physical injury or damage to the health of people or damage to property or to the environment.

NOTE 2 The term hazard can be qualified in order to define its origin or the nature of the expected harm.

3.8
risk
combination of the probability of occurrence of harm and the severity of that harm

[ISO/IEC Guide 51:1999]

3.9
risk analysis
use of available information to identify hazards and to estimate the risk

[ISO/IEC Guide 51:1999]

3.10
risk evaluation
judgement, on the basis of risk analysis, of whether a tolerable risk has been achieved

[ISO/IEC Guide 51:1999]

3.11
risk assessment
overall process of risk analysis and risk evaluation

[ISO/IEC Guide 51:1999]

3.12
reliability
ability of a system or component to perform a required function under specified conditions and for a given period of time without failing

3.13
shutdown
automatically or manually initiated action to achieve a safe condition of the pressure equipment

3.14
lockout
system feature which preserves the shutdown action until it is released by a manual intervention

3.15
safety related measurement, control and regulation system (SRMCR)
system which by means of automatic control equipment, operating independently from other process control functions, prevents operating parameters exceeding allowable limits in pressure equipment

3.16
limiter
device which either activates the means for correction or provides for shutdown or shutdown and lockout

3.17
safety
freedom from unacceptable risk

[ISO/IEC Guide 51:1999]

3.18
self-diagnosis
regular and automatic determination that all chosen components of a safety system are capable of functioning as required

3.19
maximum allowable pressure (*PS*)
maximum pressure for which the equipment is designed, as specified by the manufacturer

3.20
maximum/minimum allowable temperature (*TS*)
maximum/minimum temperatures for which the equipment is designed, as specified by the manufacturer

3.21
redundancy
provision of more than one device or system which is sufficient to perform or provide the necessary function

3.22
controlled safety pressure relief systems (CSPRS)
pressure relief system conforming to prEN ISO 4126-5

4 Risk consideration

4.1 General

All service conditions shall be considered to select the most appropriate safety concept to ensure safe operation. This requires a realistic assessment of risk by means of risk analysis and risk evaluation (see Figure 2).

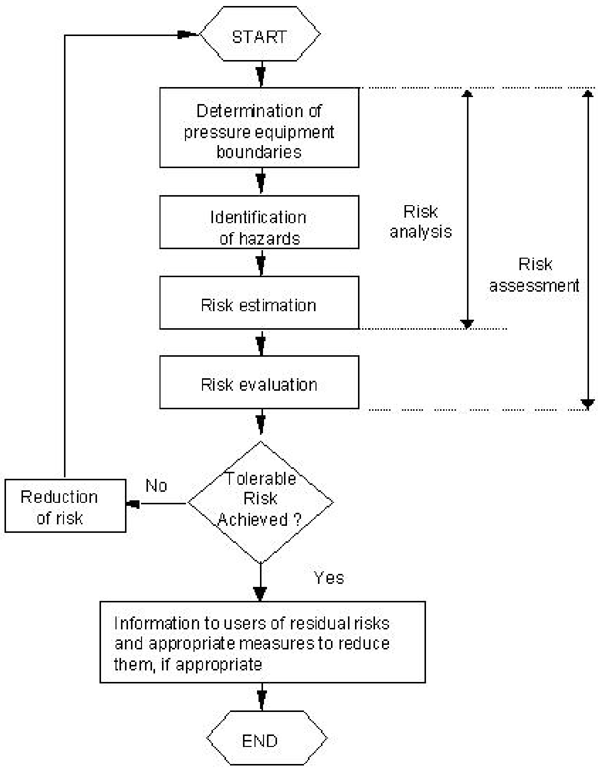
Risk analysis involves:

— Determination of the boundaries of the pressure equipment including intended use and reasonably foreseeable misuse;

— Identification of potential hazards and estimation of the risk.

Risk evaluation involves the process in which, on the basis of risk analysis, judgement is made to achieve a tolerable risk.

NOTE The manufacturer and the user should consider the most onerous conditions which can exist for pressure and temperature within the allowable limits.



NOTE Risk reduction and the selection of safety systems are not part of risk analysis and risk assessment.

Figure 2 — Process for risk assessment and risk reduction

4.2 Identification of hazards

During operation of a piece of pressure equipment, dangerous situations may occur due, for example to:

— operational aspects;

— human errors;

— unreliability of some functions;

— unsafe loading conditions;

— maintenance;

— physical characteristics of the fluid:

  a) pressure;

  b) temperature;

  c) flow;

  d) level;

  e) fouling capability;

  f) adhesion;

  g) abrasion;

— chemical characteristics of the fluid:

  a) corrosivity

  b) toxicity;

  c) flammability;

  d) stability;

  e) fouling;

— site conditions such as:

  a) vibration;

  b) temperature (e.g. freezing);

  c) wear;

  d) corrosion;

  e) external fire (see 7.2)

Each of these factors can result in the operating limits of the pressure equipment being exceeded.

4.3 Solutions

Risk assessment shall be used to produce the basic information which is needed to correctly design the pressure equipment and to select the most efficient safety accessories. The equipment shall be designed in order to:

a) eliminate or reduce hazards;

b) provide appropriate protection measures if the hazard cannot be eliminated;

c) inform the user of residual hazards and indicate the appropriate special measures for that case;

d) prevent the danger from misuse.

Preference shall be given to inherently safe design solutions.

Operating instructions shall include instructions for inspection and maintenance to ensure that the required level of protection is available.

NOTE Inspection and maintenance of safety systems are necessary to ensure that the required level of integrity is maintained. A record should be kept on both the procedures and findings

5 Limiting devices and systems

5.1 General

Where the allowable limits can be exceeded, the pressure equipment shall be fitted with, or provisions shall be made for the fitting of:

a) Regulating systems:

Where appropriate, manually or automatically operated regulatory devices for the control of operating parameters such as measurement, control and regulation devices (MCR), pressure switches, temperature switches, level switches and flow switches to maintain conditions during normal operation within the maximum / minimum allowable limits;

b) Monitoring systems:

Where appropriate, adequate monitoring devices for the control of operating parameters such as measurement, control and regulation devices (MCR), indicators, alarms, pressure switches, temperature switches, level switches, flow switches which enable adequate action to be taken either automatically or manually or activate the means for correction and/or provide for shutdown and lockout, to keep the pressure equipment within the allowable limits.

If the process parameter value cannot exceed the allowable limits, a monitoring system is sufficient and a safety system unnecessary. The process parameter can be brought back into the normal operating range by:

- manual action - after a status signal; or

- automatically;

c) Safety systems:

Safety devices such as safety valves, bursting disc safety devices, buckling rods, CSPRS, etc. or safety related measuring, control and regulation devices (SRMCR), which serve as ultimate protection to ensure that the maximum allowable operating limits are not exceeded.

Safety systems or their relevant components shall be independent of other functions, unless their safety function is not affected by such other functions.

NOTE 1 See definition of independence.

NOTE 2 Regulating and monitoring systems which are not part of a safety systems are not covered by this standard.

5.2 Design

5.2.1 General

The safety system shall be designed to operate sufficiently reliably under all conditions of operation determined by the risk analysis in 4.1, including start up, shut off, and during maintenance and repairs.

All limiters, and their components, installed in a safety system shall comply with the requirements of this clause and 6.6. Additional requirements for particular types of limiters are given in annex B.

5.2.2 Material and design

5.2.2.1 Limiters shall withstand the thermal, mechanical, chemical and electrical loads that can occur during operation.

5.2.2.2 The use of materials with great differences in their electrochemical potential shall be avoided in order to prevent corrosion which would affect the function of the limiter.

5.2.2.3 Chambers, connecting pipes and protection tubes for the limiters shall be designed so that they can be cleaned and inspected. They shall also be suitably designed to prevent the build up of deposits in the tubes/chambers.

5.2.2.4 Protection tubes and chambers shall be designed to allow the device to have an adequate response time.

5.2.3 Internal Protection Tubes

5.2.3.1 Where an internal protection tube is necessary, for example, in order to prevent the effect of foam or turbulence, then the protection tube shall be considered to be part of the equipment to be protected.

5.2.3.2 Openings on the protection tube which are necessary in order to ensure level equalisation shall be properly sized and shall be positioned at the lowest point of the bottom and at the highest practicable point of the protection tube.

5.2.4 External Chambers

The pipe connections to external chambers shall ensure that the parameter to be measured is representative of the parameter in the main equipment.

5.2.5 Electrical equipment

5.2.5.1 Electrical equipment shall comply with prEN 50156-1.

5.2.5.2 All wiring and electrical equipment in connection with safety systems shall be adequately protected against ingress of moisture and effects of high temperature.

5.2.5.3 Electrical components within the confines of limiting devices shall be able to withstand the temperature of the surrounding environment. Any equipment which is in contact with parts carrying the process fluid shall be able of withstanding the highest temperature resulting from contact with:

— the process fluid at the highest temperature; or

— the saturated vapour of the process fluid at the highest foreseeable pressure; or

— any fluid used periodically to clean the equipment.

5.2.5.4 Safety accessories shall have, as a minimum, a protection rating to IP54 of EN 60529:1991. When components are installed inside an enclosure or control box, the IP rating required for the box shall be considered adequate.

5.2.5.5 The limiter shall be designed so that a fault in any related part shall not lead to a loss of the safety function. This may be achieved by fault avoidance techniques, self-diagnosis, redundancy, diversity or a combination of these methods. Fault assessment for the electrical components shall be in accordance with the procedure in the fault analysis charts of prEN 50156-1. The figure "Fault assessment for the hardwired section of a safety device" in this standard shall also be applied for faults in hydraulic, pneumatic and mechanical components.

5.2.5.6 Limiters shall function independently of each other and of other control systems unless their safety function cannot be affected by other such functions. Limiters may, however, share common components (e.g. power supplies, bus systems, circuit boards, etc.) provided each limiter is fail-safe as defined in 3.6 and no adverse safety effect can occur from faults in other limiters or related equipment.

5.2.5.7 The limiter shall be designed in such a way that once it has been activated, sent the appropriate signals and prevented the allowable limits being exceeded, manual resetting is required after the relevant process parameter has been restored to a safe level and all possible causes of the fault have been corrected.

6 Pressure limitation

6.1 General

6.1.1 Selection

Safety accessories which may be suitable for pressure limitation are:

— safety valves:

  a) direct loaded;

  b) pilot operated;

— bursting disc safety devices;

— safety valves and bursting disc safety devices in combination;

— controlled safety pressure relief systems (CSPRS);

— safety related measurement, control and regulation devices (SRMCR);

— other safety devices, or combinations, provided that they are demonstrated to be suitable and reliable for the purpose of pressure limitation.

The safety device, or combination of safety devices, shall reach the required safety and reliability level.

Where discharge is not possible non relieving safety devices such as SRMCR shall be installed.

If none of these safety devices is suitable for the application then the vessel or the compartment of the vessel shall be designed to withstand the maximum foreseeable pressure.

NOTE 1 When selecting the type, number and size of safety devices, it is important to consider the impact on the design of the downstream disposal system, which can be an existing facility.

NOTE 2 In the case of relieving devices in general, self reclosing safety devices are preferred for equipment protection, but bursting disc safety devices or a combination of bursting disc safety devices and safety valves can be preferable in certain circumstances (see prEN ISO 4126-6) in accordance with the requirements of this clause.

NOTE 3 Further guidance on the selection of safety systems is given in annex C.

6.1.2 Operation

During normal operation of the equipment the pressure shall be limited to the maximum allowable pressure *PS*.

6.1.3 Protection

Where, under reasonably foreseeable service conditions, the internal pressure can exceed the maximum allowable pressure *PS*, the equipment, assembly or compartment of the equipment shall be protected by means of a safety system.

6.1.4 Pressure limit

Pressure limiting devices shall be effective at a pressure such that the pressure in the equipment is prevented from exceeding 1,1 times the maximum allowable pressure *PS* with the exception of external fire (see 7.2).

6.1.5 Discharge capacity

The total capacity of a pressure relief device(s) fitted to any pressure equipment shall be sufficient for all foreseeable conditions to prevent a rise in pressure of more than 10 % above the maximum allowable pressure *PS*. This may be proved by testing or by means of calculation.

Piping capacity shall be sufficient to ensure that no items of equipment are subjected to a pressure greater than 1,1 *PS* in any relieving scenario.

The effect of back pressure on the capacity of any safety valve shall be taken into account.

NOTE The valve manufacturer may need to be consulted about the effect of back pressure on the capacity of any safety valve.

6.1.6 Liquid applications (Thermal expansion)

Equipment which operates completely filled with liquid and which can be isolated, shall be equipped with a pressure relieving device to protect against exceeding the maximum allowable pressure due to thermal expansion, unless otherwise protected against excessive pressure.

6.1.7 Vacuum applications

In cases where vacuum conditions can occur and the vessel is incapable of withstanding such conditions, a vacuum relief device shall be fitted to automatically allow a suitable fluid to enter the vessel to prevent the allowable vacuum being exceeded.

6.1.8 Failure of components

Where the results of the risk assessment indicate that a component failure, or a combination of failures, during operations is possible which can cause the pressure in the equipment to exceed the maximum allowable pressure *PS*, then this failure shall be considered when evaluating the total capacity of the pressure relief devices.

6.2 Safety valves, direct loaded and pilot operated

6.2.1 Design

6.2.1.1 Safety valves shall comply with

— prEN ISO 4126-1 Safety valves; or

— prEN ISO 4126-4 Pilot operated safety valves.

NOTE For liquid service, valves certified at more than 10 % overpressure are also permitted (see also 6.2.2.6).

6.2.1.2 Safety valves for steam and compressed air duties may be provided with lifting (easing) gear. The gear shall be arranged so that the valves can be lifted positively off their seats when under operating pressure and shall be such that it cannot lock or hold the valve off its seat when the external lifting force is released.

NOTE 1 For equipment containing other than steam or air, easing gear may be not appropriate.

NOTE 2 For equipment containing fluids which might create a hazard, easing gear should not be provided unless leakage of the fluid is prevented other than through the discharge line.

6.2.2 Selection of the set pressure

6.2.2.1 Safety valves shall have a set pressure not exceeding the maximum allowable pressure *PS* of the equipment, except as permitted in 6.2.2.2 or 6.2.2.3.

6.2.2.2 If the required discharge capacity is provided by more than one safety valve, only one of the valves needs to be set as specified in 6.2.2.1. The additional valve or valves may be set at a pressure not more than 5 % in excess of the maximum allowable pressure *PS* providing the requirements of 6.1.4 are met.

NOTE Additional information is contained in annex A.

6.2.2.3 Alternatively the safety valve set pressure may be above the maximum allowable pressure *PS* providing that:

— the valve(s) can attain the certified capacity at 5 % overpressure or less; and

— the requirements of 6.1.4 are met; and

— an additional pressure limiter is fitted to ensure that the permitted maximum allowable pressure *PS* is not exceeded (including peak values) during continuous operation.

6.2.2.4 The pressure at which a safety valve is set to open shall take into account the effect of the fluid temperature, static head and superimposed back pressure (fixed or variable).

6.2.2.5 The normal operating pressure of the system shall be below the reseat pressure, the difference being chosen on the basis of probable variations in operating pressure due to process factors and the tolerance on cold differential test pressure (see Figure 4).

6.2.2.6 With supplementary loaded safety valves, failure of the supplementary load to be released will result in the valve remaining closed until a pressure higher than the desired set pressure is reached. If the integrity of the release of the supplementary load cannot be assured, the certified capacity of the supplementary loaded safety valve shall be achieved at a pressure not greater than 1,1 times *PS*.

NOTE In some cases the required discharge capacity of the valve can not be reached until an overpressure of 25 % above the set pressure is reached. If the discharge capacity is certified at more than 10 % overpressure then the set pressure should be set at a lower value than *PS* in order to meet the requirements of 6.1.4. A reasonable margin is required between the normal operating pressure of the equipment and the reseating pressure of the valve and as a result the normal operating pressure can be as much as 25 % below the maximum allowable pressure *PS* of the equipment. Alternatively larger valves of the proportional lift type can be fitted.

The relationship of set pressure and overpressure at which the safety valve attains its certified capacity is illustrated in Figure 4.

6.2.3 Sizing

The relieving pressure used to calculate the minimum flow area through a safety valve shall be 1,1 times the maximum allowable pressure *PS* for all overpressure scenarios. The exceptions to this are:

— external fire, where a higher relieving pressure may be allowable (see 7.2);

— applications (for example, batch reactors) where it can be necessary to consider the dynamics of the overpressure scenario and size the valve for a relieving pressure less than 1,1 times *PS*.

Sizing shall take into account the inlet line pressure drop and the developed back pressure (see 6.2.2.4 and 8.2.3).

For the sizing of multiple safety valves see annex A.

6.3 Bursting disc safety devices

6.3.1 Design

Bursting Disc Safety Devices shall comply with prEN ISO 4126-2.

6.3.2 Selection, application and installation

6.3.2.1 Bursting disc safety devices - Selection, application and installation shall be in accordance with prEN ISO 4126-6.

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

NOTE See Figure 5.

6.4 Safety valves and bursting disc safety devices in series or parallel

6.4.1 Design

For cases where safety valves and bursting disc safety devices are installed in series with the bursting disc installed within 5 pipe diameters upstream of the safety valve, the combination shall comply with prEN ISO 4126-3. Bursting disc safety devices installed downstream of a safety valve shall comply with the requirements of annex D.

6.4.2 Application

6.4.2.1 A bursting disc safety device may be mounted in series upstream of a safety valve provided that:

a) the requirements expressed in 6.3.2 are met;

b) the bursting disc safety device after rupture does not interfere with the proper functioning of the safety valve;non-fragmentable discs should be used as far as possible. If fragmentable bursting discs are used it shall be ensured by appropriate provisions (e.g. catching devices) that fragments of the burst element can not impair the functioning of the safety valve.

6.4.2.2 When a bursting disc safety device is fitted in series with a safety valve, the space between them, whatever the distance, shall be fitted with a device to detect leakage past the disc or through the valve.

If the fluid is not in the dangerous fluid category it is possible to replace the leak detection device by a suitable discharge device (e.g. vent or drain) but in all cases the operator shall be informed of fluid present downstream of the bursting disc safety device.

In the case of a bursting disc devices in parallel with a safety valve to protect a vessel against the consequences of a rapid reaction hazard, the bursting disc shall be rated to burst at a pressure not greater than 1,1 times PS at coincident temperature taking all the appropriate tolerances into account. The safety valve shall be set in accordance with 6.2.2.

6.5 Controlled safety pressure relief systems (CSPRS)

Controlled Safety Pressure Relief Systems shall conform to prEN ISO 4126-5.

6.6 Safety related measuring, control and regulation systems (SRMCR)

6.6.1 General

A SRMCR is an instrumented system which prevents operating parameters from exceeding permissible limits and creating an operating or environmental hazard, usually by eliminating the source of the operating excursion. It is often used as an alternative where a pressure-relieving device is either technically or economically unfeasible. It is sometimes known as a High Integrity Pressure Protection System.Typical applications for an SRMCR can be:

— avoidance of combinations of process variables which have the potential to generate unacceptable pressures as a result of runaway reactions, foaming of viscous fluids or charging errors;

— shut-off of materials inflow, isolation of external pressure sources or heating facilities;

— initiation of measures to correct processing errors, such as injection of inhibitors, activation of a cooling system, pressure relief into a blow-down vessel and/or process isolation.

6.6.2 Design

6.6.2.1 General

A SRMCR shall be designed using the principles in IEC 61508.

NOTE Further guidance is available in other standards including NAMUR NE 31.

A fault within the safety related parts or a disturbance from outside shall not lead to a unacceptable situation. The procedure for the selection and design of safety measures shall include a hazard analysis and risk assessment to obtain a sufficient level of integrity.

The pressure equipment and the SRMCR shall remain safe when foreseeable human mistakes are made during the intended use of the whole system (see also EN 954-1:1998, 4.1).When fluctuations in energy levels outside the design operating range occur, including loss of energy supply, the safety related parts of the control system shall provide outputs which will enable other parts of the system to maintain safe conditions (see also EN 954-1:1998, 5.2.9).

6.6.2.2 Reliability

With regard to the reliability expected of SRMCR systems the following shall be considered:

— the selection of an appropriate system and its constituent components for the duty required;

— the layout of the system with regard to measurement, value registration, signal transmission and actuator response.

An SRMCR shall be designed with sufficiently high integrity that it can be relied upon to provide the necessary function upon demand. This integrity shall be determined from a risk assessment.

NOTE In general the SRMCR should be designed to achieve the Safety Integrity Level (SIL) resulting from the detailed, comprehensive and realistic risk assessment and risk reduction allocation undertaken in accordance with IEC 61508.

6.6.2.3 Safeguarding

SRMCR shall be protected against unauthorised or unintentional manipulation (e.g. re-setting or deactivation) and against physical impact, damage or weather influences.

6.6.2.4 Independence

SRMCR installations shall function independently of all other functions. Where signals from a SRMCR are used for other than safety related functions the communication shall be unidirectional so that there can be no possibility of any feed-back or interference with the safety related functions.

All energy supplies to an SRMCR shall either be completely separate from energy supplies for the process or be backed-up by suitable resources unless the SRMCR is designed to fail to safety in the case of loss of energy.

6.6.2.5 State indication

SRMCR, and where applicable system components, shall be equipped with visual and/or audible indicators or warning signals for the control of system/component availability and the state of activation. The indication of the system state shall be located at the process control panel or at the distributed control system. The indication of component state shall be similarly located or at the device, as appropriate.

6.6.3 Documentation

For all SRMCR applications documentation shall contain sufficient information to provide:

- definite identification of the individual system;
- identification of the related components;
- an understanding of the function of the system and components;
- an understanding of the layout and technical data of the equipment to be protected;
- setting values and the appropriate tolerances;
- a record of any changes made to the settings;
- maintenance requirements (including routine testing);
- supervision requirements.

SRMCR installations shall be routinely supervised, checked for accuracy and maintained on a periodic basis in order to fulfil the design intent.

7 Hazard protection

7.1 Internal

If hazards can occur for reasons other than overpressure, the pressure equipment shall be protected by appropriate measures, limiters, protection or safety devices, in order to maintain conditions within the maximum/minimum allowable operating limits.

7.2 External

Where there is a potential risk for external hazards, such as fire or impact, the pressure equipment shall be protected against them in order to keep the equipment within safe limits.

NOTE Protection against over-pressurisation during external fire should be based on a detailed thermal response evaluation similar to the risk evaluation (see Figure 2). Pressures higher than 1,1 *PS* can be permitted depending on the damage limitation requirement. Following fire attack the equipment should not be returned to service without a thorough review of its fitness for service.

7.3 Static electricity

Precautions shall be taken to avoid accumulation of electrical charges.

NOTE Guidance and recommendations for the avoidance of hazards due to static electricity are given in CENELEC Report R044-001.

8 Installation of pressure relieving devices

8.1 General

8.1.1 Pressure relieving devices shall be so installed as to preclude injury to personnel by the relieving process. Pressure shall be vented to a safe location. The effects of the discharge on the environment shall be considered.

8.1.2 Whenever possible, the pressure relief shall follow a short, straight path. The reaction force which occurs as a result of the pressure relief shall be taken into consideration.

8.1.3 Common discharge pipes shall have a sufficient capacity, such that when one or more devices are discharging, there shall be no unacceptable super-imposed back pressure on the remaining devices which may be required to discharge during the failure scenario.

8.1.4 Wherever possible, pressure relieving devices shall be installed such that the discharge line is free draining to the disposal system. Where this is not possible and there is the possibility of liquid collecting in a discharge line, a drain shall be provided to a safe location and consideration given to the prevention of freezing of any liquid build-up. In a liquid system, the impact of static discharge head on the set pressure of a relief valve shall be taken into account.

8.1.5 If pressure discharge pipes are fitted with components to prevent ingress of rainwater or foreign bodies, these components shall not obstruct the free and full discharge of the safety devices.

8.1.6 If the pressure relieving device can discharge a flammable fluid, the danger of ignition in the discharge pipe shall be considered and appropriate measures taken to minimise the hazard.

8.2 Safety valves or the main valve of a CSPRS

8.2.1 General

8.2.1.1 Flange bolting and gaskets

Bolts and gaskets shall be of the correct type, material and dimensions. Gaskets shall not obstruct any part of the bore of the safety device or its inlet or discharge piping.**Stress considerations**

Requirements a) to c) shall be met for all operating modes of the plant including start up, shutdown and discharge:

a) External loads

The inlet and outlet piping shall be supported to ensure that no unacceptable external mechanical loads are transmitted to the safety valve or the main valve providing the safety function. In addition, the inlet and outlet piping shall be sufficient to withstand the effects of the reaction forces when the valve discharges;

b) Thermal stresses

Provision shall be made to accommodate any thermal stresses induced in the inlet and outlet piping;

c) Vibration stresses

Vibration stresses, including those caused by poor flow geometry in inlet and outlet piping systems shall be minimised to avoid leakage across the seat of the safety valve and fatigue failure of the valve and piping.

8.2.1.3 Location in gas and liquid space

If equipment contains both liquid and gas, and gas is to be relieved, a safety valve for use with gases shall be connected to the equipment in the gas space or piping connected to this space and located in a position chosen to minimise the entrainment of liquid when the valve discharges. Alternatively, if liquid to be relieved, a safety valve for use with liquid shall be connected to the equipment below the liquid level at a point chosen to prevent ingress of gas.

NOTE If two phase flow is possible, the design of relief systems will require special consideration.

8.2.1.4 Proximity to pressure source

The connection between the safety valve and the equipment shall be as short as possible and have a bore area at least equal to the valve inlet. With all installations, the pressure drop in the inlet piping system to the safety valve shall be in accordance with 8.2.2.

NOTE 1 In installations where there are pressure pulsations, the valve or the connection should be located in a region where the effects of the pulsations are minimised, consistent with maintaining correct operation of the safety valve.

NOTE 2 Particular care should be taken in selecting a connecting pipe in the NPS (Nominal Pipe Size) system since the bore can be smaller than the nominal size.

8.2.1.5 Sensing line

The line shall incorporate a siphon, where applicable, and stop valves with a test connection to enable the pressure settings and the correct functioning of the instrumentation to be checked.

NOTE The sensing line is the line between the pressure sensor and control module (for CSPRS) or the line between the pressure equipment and the pilot (for Pilot Operated Safety Valves).

For assisted opening and supplementary loaded safety valves, the connection for the sensing line at the pressure source shall be located as remotely as possible from the safety valve mounting to minimise the effect of localised pulsations and system vibrations in the sensing line when the valves are operating.

The length of the pressure sensing line should be as short as practicable in order to avoid dynamic problems.

8.2.1.6 Mounting position

If a valve is required to be installed in other than the vertical position its ability to operate correctly in the required position shall be checked.

8.2.1.7 Accessibility

Easy access and sufficient workspace and height shall be provided for the servicing and removal of safety valves.

8.2.2 Inlet piping

The bore of the inlet piping, between the protected equipment and the inlet of the valve, shall not be less than that of the safety valve inlet.

The inlet piping should be as short as practicable and shall be designed so that the total frictional pressure drop from the protected equipment to the valve inlet does not exceed 3 % of the set pressure of the safety valve.

NOTE 1 The pressure drop should include the vessel nozzle entrance loss but not any exit loss from the pipework to the safety valve.

The total inlet pressure drop shall be calculated using the actual flowing capacity which is the certified capacity of the safety valve divided by the derating factor 0,9. The pressure drop shall include the effect of any isolating valves.

When calculating the capacity of a safety valve, the actual pressure and temperature existing at the valve inlet shall be used, taking into account the pressure drop between the equipment to be protected and the valve.

In the case of pilot operated safety valves (POSV) and the main valve of a CSPRS, where the pressure drop is less critical, the pressure drop shall be considered in the calculation of mass flow or flow area.

NOTE 2 Isolating valves, and fittings, in the inlet piping to a safety valve should preferably be of the full bored type. Adverse effects on safety valve performance arising from pressure drop in the inlet line can be reduced by rounding the entrance to the inlet or by the use of larger inlet piping.

8.2.3 Outlet systems

The discharge shall be disposed of safely and be prevented from unintentional flowing into other equipment to create a hazard (for example, into equipment out of service or undergoing maintenance).

The discharge pipe, between the outlet of the valve and atmosphere or venting system, shall be adequately drained.

NOTE It can be difficult to provide drainage points in a closed disposal system, but in this case the routing of the pipework should avoid any low points where liquid can accumulate.

Discharge pipes should be as short as practicable and have a bore at least as large as the valve outlet.

The requirements for isolating valves in outlet systems are addressed in 8.5.5.

If the discharge is routed directly to the atmosphere, it shall be to a safe location, clear of adjacent equipment and areas normally accessible to personnel.

NOTE The outlets from individual safety valves can be combined in a manifold and into a common discharge pipe.

The variation in superimposed and built-up back pressure and their effect on the operation and capacity of the relief valve in all failure scenarios shall be fully assessed and taken account of in the sizing and selection of the relief valve. Where a silencer is provided the additional back pressure shall be taken into account.

In calculating the capacity of the safety valve the design of the discharge line shall ensure that the discharge velocity shall be less than the sonic velocity.

8.3 Installation of bursting disc safety devices

Installation of bursting disc safety devices shall conform to prEN ISO 4126-6 and the requirements of 8.4.1.

8.4 Safety valve & bursting disc safety devices in combination

8.4.1 Combination

Safety valves and bursting disc safety devices may be combined in series or parallel to form a safety system. In series combinations the bursting disc safety device can be installed upstream or downstream of the safety valve.

When the bursting disc safety device is mounted in series upstream of the safety valve within a distance of five pipe diameters, the combination shall be in accordance with prEN ISO 4126-3. Where the bursting disc safety device is mounted more than 5 pipe diameters before the safety valve or in other configurations (e.g. installed on the outlet of the safety valve) the requirements of 6.4.2 and 8.4.2 shall be met.

8.4.2 Inlet piping to combination

The area of the inlet piping, between the protected equipment and the inlet of the valve, and that through the bursting disc shall not be less than that of the safety valve inlet.

The inlet piping should be as short as practicable and shall be designed so that the total pressure drop to the valve inlet, including the effect of the bursting disc, does not exceed 3 % of the set pressure of the safety valve.

The total inlet pressure drop shall be calculated using the actual flowing capacity which is the certified capacity of the safety valve divided by the derating factor 0,9. The pressure drop shall include the effect of the bursting disc and any isolating valves.

8.4.3 Outlet piping

See 8.2.3.

8.5 Isolation of relieving safety systems

8.5.1 Basic requirement

The equipment shall be protected against excessive pressure at all times during operation.

8.5.2 Isolating valves

There shall be no isolating valves in the inlet or outlet line of a safety system except as specified in 8.5.3, 8.5.4 and 8.5.5.

The design and installation of all isolation valves shall not introduce an unacceptable pressure drop, reduce the relief capacity below that required, or affect the proper operation of the relieving safety accessories. Reference shall be made to 8.2.2 regarding pressure drop limitations.

8.5.3 Simultaneous isolation of the relieving safety accessories and the pressure source

Isolation of the pressure relieving safety accessory(ies) from the equipment which it is designed to protect shall only be permitted if the source of pressure, which could lead to an unsafe condition, is simultaneously isolated from the equipment with the pressure relief device. A typical arrangement is shown in Figure 3.

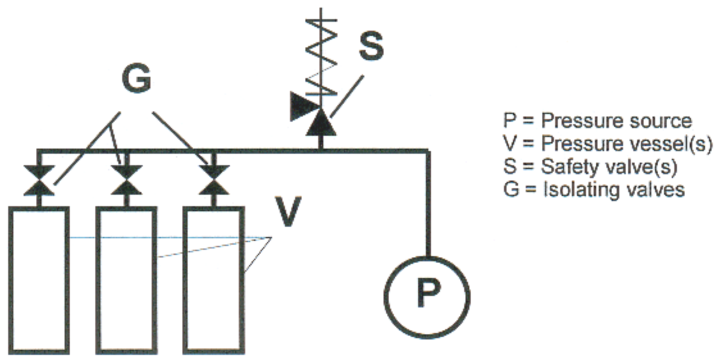


Figure 3 — Illustration of one method of simultaneous isolation

Prior to isolation the continued need to protect against external sources of overpressure such as solar radiation and fire shall be addressed.

8.5.4 Multiple relieving safety accessories

Any provision made for isolating any one relieving safety accessory (e.g. for testing or servicing) shall ensure that the remaining relieving safety accessory(ies) connected to the equipment shall provide the full relief capacity required.

Acceptable methods include but are not limited to:

- 3-way valves;
- changeover valves;
- mechanical interlocks;
- captive sequential key interlocking.

8.5.5 Locking of isolating valves in a common discharge system

If it can be demonstrated that the installation of an isolating valve is the only credible means of permitting maintenance on a safety device, then an isolating valve can be installed in a common discharge system. In this case it shall be ensured that the outlet line is not blocked during operation by providing one of the locking devices described in 8.5.4.

NOTE The position of the valve and the locking device should be checked periodically.

8.5.6 Venting

A vent or bleed valve shall be fitted to the space between an isolating valve and the safety device so that the space may be depressurized before commencing the removal of the device.

Consideration shall be given to the presence of toxic or hazardous fluids.

9 Indicators and alarms

9.1 General

When indicators and/or alarms are installed as a part of a safety system they shall fulfil the requirements of this clause.

They shall be located where the protective action has to be made, on site or in a control room.

NOTE Indicators should be checked for accuracy on a periodic basis. The frequency of checking and the degree of accuracy should depend on experience gained from similar applications. If the user is not able to make the necessary assessment of reliability then advice should be obtained from experts.

9.2 Pressure indicators

All pressurised systems shall be fitted with at least one pressure indicator.

The connecting lines shall have a bore which, bearing in mind the nature of the system fluid, is unlikely to become blocked and shall be so arranged that the indicator is protected from unacceptable temperatures.

Indicators mounted at an elevation different from the measuring point shall be compensated for static head difference.

It shall be possible to install a test gauge for verification purposes in the vicinity of the pressure indicator.

For all positive pressures, the indicator shall indicate gauge pressure in bar and have a permanent and easily visible indication of the maximum allowable pressure.

Analogue pressure gauges, based on a Bourdon tube shall conform to EN 837-1 and EN 837-3 and the normal reading shall be in the middle third of the scale.

In the case of digital indications the maximum allowable pressure, *PS,* shall be indicated adjacent to the readout for easy comparison.

9.3 Temperature indicators

If temperature is a safety consideration, the pressurised system shall be provided with a temperature indicator of adequate response time which shall ensure that the temperature is always known and clearly displayed.

The indicator shall indicate the appropriate temperature in degrees Celsius and shall have a permanent and easily visible indication of the maximum allowable temperature, *TS*.

In the case of digital indicators the maximum and/or the minimum allowable temperature, *TS*, shall be indicated adjacent to the readout for easy comparison.

9.4 Liquid level indicators

If liquid level is a safety consideration, a vessel shall be provided with a level indicator which will ensure that the liquid level is always known and clearly displayed. The measuring range shall be extended above and below the permissible levels.

Any connecting pipework shall be designed to ensure correct level indication.

Where breakage can result in personal injury or loss of fluid, level indicators shall be provided with suitable protection.

NOTE It should be possible to change a gauge glass during operation and isolating valves or cocks should be provided for this purpose. There should also be a valve or cock for draining. Where cocks are fitted they should indicate the open position. Drainage or blow-down systems on liquid level indicators should be so installed to prevent accidents. Any blow-down or leakage should be detectable.

9.5 Signals and warning devices

Visual signals, such as flashing lights and audible signals such as sirens may be used to warn of an impending hazardous event.

It is essential that these signals shall be:

— clearly recognised by the operating personnel;

— clearly perceived and differentiated from other signals and alarms;

— emitted before the occurrence of the hazardous event;

— unambiguous;

— arranged to avoid the risk from sensorial saturation.

NOTE The attention of designers is drawn to the risks from ‘sensorial saturation’ which results from too frequent emission of visual and/or audible signals, which can also lead to a warning being ignored.

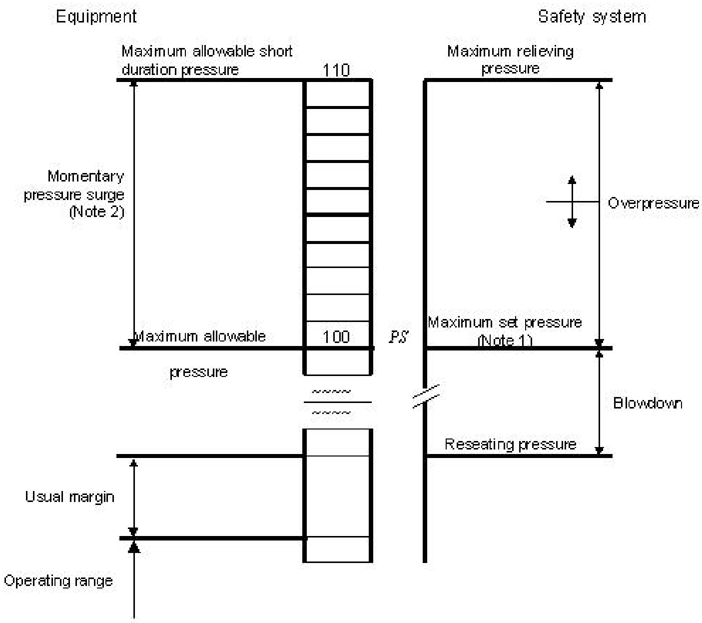
The warning devices giving these signals shall be designed and located such that functional checks can be performed. The instructions for use shall prescribe regular checking of warning devices.

10 Inspection and maintenance

Operating instructions of the safety system shall include instructions for the inspection and the maintenance to ensure that the required level of protection is available.

NOTE Inspection and maintenance of safety systems is necessary to ensure that the required level of integrity is maintained. A record should be kept on both the procedures and findings.

Maximum allowable pressure *PS*



NOTE 1 In this figure the set pressure is shown as being equal to PS, but it can be higher (see 6.2.2.2 and 6.2.2.3) or lower. If the discharge capacity is certified at more than 10 % overpressure (which is outside the scope of prEN ISO 4126) then the set pressure should be set at a lower value than *PS* in order to meet the requirements of 6.1.4.

NOTE 2 The pressure surge is limited to a short duration. In some codes and standards, the pressure surge is called accumulation, independent of the duration.

Figure 4 — Safety Valve Applications

Maximum allowable pressure *PS*

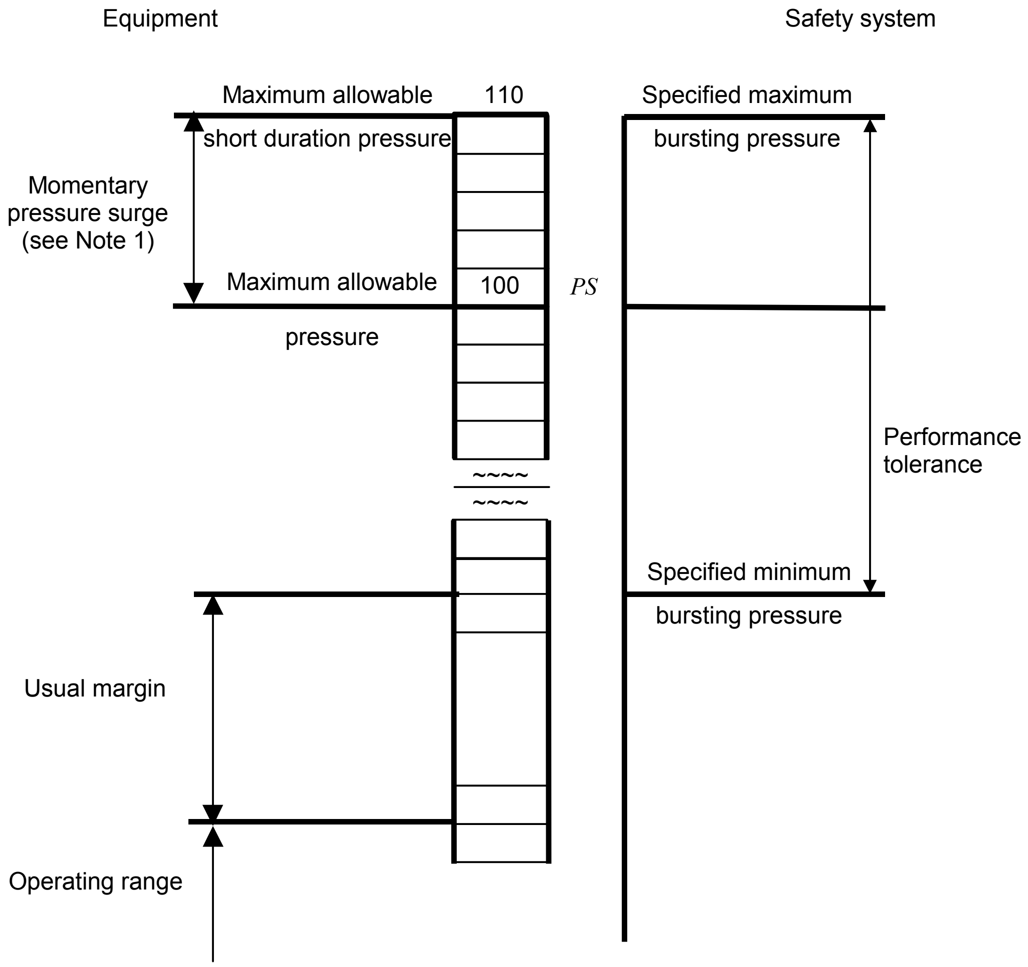


Figure 5 — Bursting Disc Safety Device Applications

Provisions shall be made to ensure that the operating pressure does not permanently exceed *PS* (see also 6.3.2.2).

NOTE The pressure surge is limited to a short duration. In some codes and standards, the pressure surge is called accumulation, independent of the duration.

Annex A
(informative)

Sizing of multiple safety valves

When more than one safety valve is fitted to a vessel, or part of a pressurised system, the relieving capacity of all of them should be calculated for the same relieving pressure. If all the valves are discharging then the actual relieving pressure will be the same and not at the individual set pressure plus some notional overpressure.

NOTE In 2.11.2 - annex 1 - of Directive 97/23/EC (Pressure Equipment Directive) it states:

"The devices must be so designed that the pressure will not permanently exceed the maximum allowable pressure PS; however a short duration pressure surge in keeping with the specifications laid down in 7.3 is allowable, where appropriate", and clause 7.3 - annex 1 - of the Pressure Equipment Directive (PED-97/23/EC) states:

"The momentary pressure surge referred in 2.11.2 must be kept to 10 % of the maximum allowable pressure".

The **maximum relieving pressure** to be used in the capacity calculations will therefore be the value of 1,1 times *PS*.

The **maximum set pressure** will depend upon the overpressure that was adopted during the tests to determine the coefficient of discharge, K_d, of the valve. Valves can be used at a greater overpressure than that used during the test but never at a lower overpressure.

Many existing valves have a coefficient of discharge which has been determined at an overpressure of 10 % so these valves could never have a set pressure greater than *PS*. In this 'Safety Systems' standard there is a possibility of having a set pressure greater than *PS* providing that the valves can attain the certified capacity at 5 % overpressure or less. This means that in order to be able to take advantage of this the safety valves will have to be chosen before deciding the design pressure of the equipment if the usual margin between the actual working pressure, including the normal deviations, and the lowest set pressure is to be maintained.

Examples:

1) A vessel with a maximum allowable pressure *PS* of 100 bar, fitted with 3 valves all having a K_d determined at 5 % overpressure and a limiting pressure under fault conditions of 110 bar can have valves with set pressures shown in Table A.1.

Table A.1 — Actual overpressures in a multi-valve installation

Valve No.	Set pressure bar	Relieving pressure bar	Actual overpressure %
1	100	110	10
2	102	110	8
3	104,8	110	5

2) A vessel with a maximum allowable pressure *PS* of 100 bar, fitted with 3 valves all having a K_d determined at 10 % overpressure would need to have the valves set differently as shown in Table A.2.

Table A.2 — Actual overpressures in a multi-valve installation

Valve No.	**Set pressure** bar	**Relieving pressure** bar	**Actual overpressure** %
1	97,8	110	12,5
2	99,1	110	11,0
3	100	110	10,0

In all these examples the maximum relieving pressure is the same, that is:

1,10 times *PS*

where

PS = maximum allowable pressure for the equipment

The basic rule is:

The relieving pressure used to calculate the *minimum* flow area through a safety pressure relief device shall always be 1,10 times *PS*.

Since the relieving devices will be available in discrete sizes it is unlikely that there will be an exact match and as a consequence the flow area will be somewhat greater than the minimum. This means that the maximum pressure will not be greater than 1,10 times *PS*.

The valve design and test conditions, used to determine the K_d, will determine the maximum set pressure of any valve.

Annex B
(normative)

Requirements for level limiters

B.1 General

Care shall be taken that if magnetic materials are chosen, they do not adversely affect the working of the limiters.

Protection tubes and external chambers shall be designed to allow free movement of the liquid level to equalise with the level in the vessel.

If isolating valves are fitted on the connecting pipes to external chambers, an interlock system shall be installed to prevent the equipment entering a dangerous state when valves are not fully open.

The chamber shall be fitted with a drain.

B.2 Floating devices

B.2.1 The float shall be guided and shall be able to move freely.

B.2.2 As the actuating force is small, it shall be converted to a positive movement with a minimum of friction.

B.2.3 Mechanical transfer shall be performed in such a way that no sticking can occur.

B.2.4 Any magnets shall be protected against influence of the fluid (e.g. suspended magnetic particles) by their position above the highest operational liquid level or by an additional shield.

B.2.5 The magnetic materials shall be selected with regard to the temperature and operating conditions.

B.3 Level electrode devices

B.3.1 The level electrodes shall be designed, positioned, installed and protected in such a way that foam and turbulence of the liquid do not affect their proper functioning.

B.3.2 Level electrode devices shall be installed vertically or at an inclination from the vertical on the provision that the particular electrode device has been tested and demonstrated to be suitable in the inclined position.

B.3.3 The limits of application with respect to the fluid conductivity shall be defined.

B.3.4 The electrodes shall be designed to withstand the mechanical influences arising during operation, such that there is no adverse positional change relative to the fitted protection tube and/or to other electrodes which will result in a failure (e.g. a short circuiting). Devices used to support or restrict movement of the electrode shall form part of a test of suitability.

B.3.5 If several electrodes are positioned within one protection tube, it is essential to ensure that the power supply is from the same phase.

B.3.6 Only one limiter electrode is permitted to be installed within a protection tube or external chamber. It is acceptable however, to install additional electrodes for control and other alarm functions. The combination shall be subjected to a test of suitability.

B.3.7 The insulation resistance of the electrode and the cable shall be monitored. In the case of low insulation resistance caused for example, by deposit built up on the insulator or internal leakage of the electrode, the system shall go into a safe state.

B.3.8 Each limiter electrode shall have an independent connecting head.

B.4 Fault detection

Functional testing of the limiters, by manually initiated instructions or processes, shall be possible at any time for any operating conditions. The equipment shall enter a safe state if the test sequence fails. The result of the test shall be clearly recognisable to the equipment operator.

Annex C
(informative)

Selection of safety accessories for pressure limitation

C.1 General

The purpose of this annex is to give general advice on the advantages and disadvantages on the selection of safety devices. The choice of the best safety device should be considered on a case by case basis depending on the design and the operating modes of the pressure equipment to be protected.

C.2 Safety valve

a) Advantages:

— closes again, loss of fluid minimized;

— shorter response time than SRMCR and CSPRS;

— process need not be shut down after function;

— influence of back pressure can be minimized (expansion bellows);

— requires no source of additional power;

b) Disadvantages:

— not able to react to a rapid pressure rise quicker than about one tenth of a second;

— sensitive to gumming, solid particles or icing;

— more difficult to protect against corrosion than bursting disc;

— periodic maintenance necessary, (frequency depends on site conditions and fluid);

— behaviour sensitive to the nature of the fluid (gas, two phase flow; liquid);

— can be difficult to reseat perfectly.

C.3 Bursting disc

a) Advantages:

— able to react quickly to a rapid pressure rise;

— not as sensitive to gumming, solid particles and icing as safety valve;

— not as sensitive to corrosive fluids as a safety valve and fails safe;

— less expensive than others;

— requires no source of additional power;

b) Disadvantages:

— does not close again, total loss of pressure and fluid;

— process must be shut down to replace bursting disc;

— more difficult to achieve accurate set point;

— bursting pressure sensitive to pressure difference across the disc;

— bursting pressure more sensitive to temperature;

C.4 Pilot operated safety valves

a) Advantages:

— margin between operating pressure and set pressure can be minimized;

— may offer improved seat tightness for large discharge areas;

— less sensitivity to the medium when operating;

— less sensitivity to back pressure;

— requires no source of additional power;

b) Disadvantages:

— complex system with sensor, sensing lines, control line and main valve;

— pressure sensing lines and control lines prone to blockage or damage;

C.5 CSPRS

a) Advantages:

— margin between operating pressure and set pressure can be minimized;

— may offer improved seat tightness for large discharge areas;

— less sensitivity to the medium when operating;

— less sensitivity to back pressure;

b) Disadvantages:

— requires an external source of power;

— complex system with sensor, sensing lines, control unit, control line and main valve;

— pressure sensing lines and control lines prone to blockage or damage;

C.6 SRMCR

a) Advantages:

— can be designed if discharge of e. g. toxic fluids is not allowed;

— possibility to control several parameters of the process instead of only the pressure;

— can avoid the need to provide a discharge system and waste disposal;

— no loss of fluid which may be expensive;

— possibility to react to changes in process conditions earlier;

— can avoid sizing problems associated with two-phase flow;

— improved flexibility for maintenance;

b) Disadvantages:

— expensive;

— requires complex analysis;

C.7 Bursting disc safety device upstream of a safety valve

Keeps the fluid from the safety valve, which is more sensitive to gumming and corrosive fluids.

C.8 Bursting disc safety device downstream of a safety valve

Keeps the back influence of the outlet system off the safety valve, which is more sensitive to gumming and corrosive fluids.

C.9 Safety valve and bursting disc in parallel

The set pressure of the safety valve is lower than the design pressure of the pressure equipment and lower than the bursting pressure of the disc. The safety valve closes again after a slow pressure rise. For rapid pressure rises or in external fire situations the bursting disc safety device is able to provide additional pressure relief.

C.10 Safety valves in parallel

If the risk assessment shows hazards with different required discharge capacities, it can be useful to have a safety valve with a reduced set pressure in parallel with a bigger or several safety valves, in order to avoid the opening of all the valves every time the allowable pressure limits are exceeded.

Annex D
(normative)

Bursting disc safety devices downstream of safety valves

Bursting disc safety devices may be installed on the outlet side of a safety valve provided that:

1) The safety valve is so designed that it will not fail to open at its proper pressure setting regardless of any back pressure that can accumulate between the valve disc and the bursting disc safety device;

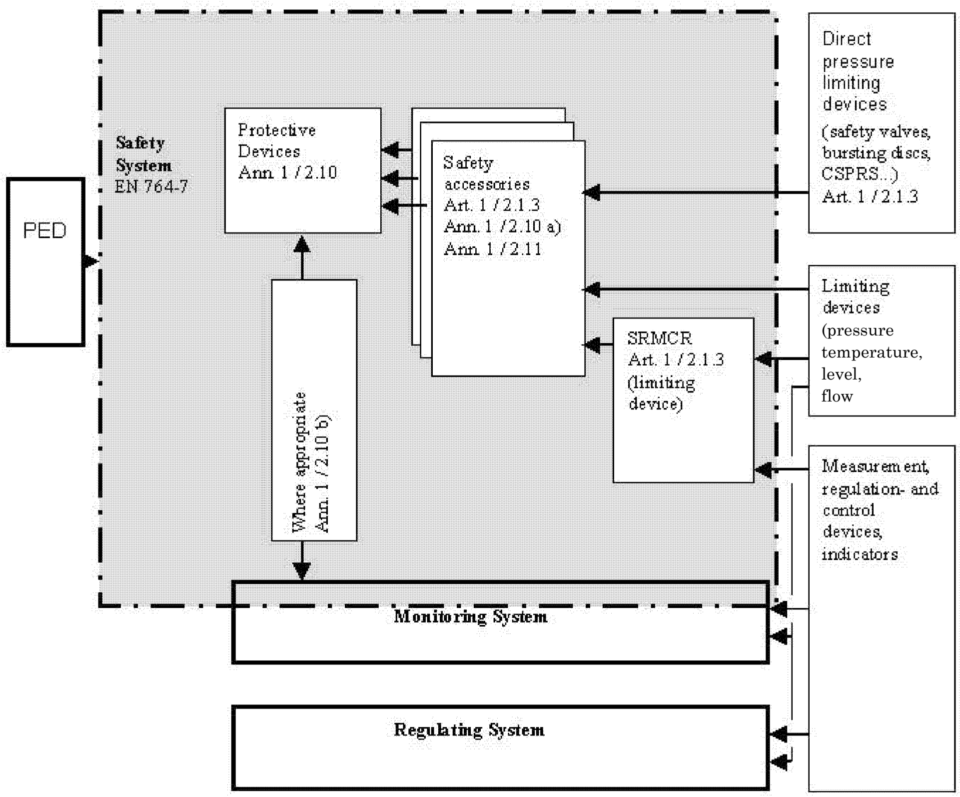
2) The space between the valve disc and the bursting disc safety device shall be vented or drained to prevent accumulation of pressure due to a small amount of leakage from the valve;

3) The bursting pressure of the bursting disc safety device at the coincident disc temperature plus any pressure in the outlet piping shall not exceed the design pressure of the outlet portion of the safety valve and any pipe or fitting between the safety valve and the bursting disc safety device. In no case shall the bursting pressure of the bursting disc safety device at the coincident temperature plus any pressure in the outlet piping exceed the maximum allowable pressure of the pressure equipment or the set pressure of the safety valve.

Annex E
(informative)

Scope of the standard

Scope of this European Standard and references to the Pressure Equipment Directive (97/23/EC)



Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives

This European Standard has been prepared under a mandate given to CEN by the European Commission and supports essential requirements of EU Directive 97/23/EC (PED).

WARNING: Other requirements and other EU Directives may be applicable to the systems falling within the scope of this standard.

The following clauses of this standard provide one means of conforming to the specific essential requirements of the Directive concerned and associated EFTA regulations.

Table ZA.1 — Clauses of this European Standard addressing Essential requirements of EU Directive 97/23/EC

Relevant clauses of this European Standard	Essential requirements of Directive 97/23/EC	Relevant clause of annex I of PED
4	Hazard reduction or protection against hazards	1.2
6.6.2.1 ; 6.6.2.3	Potential for misuse	1.3
6.1 ; 6.6.2	General design	2.1
8.1 ; 8.2.3	Safe handling and operation	2.3
8.1.4 ; 8.1.5 ; 8.2.3 ; 8.5.6	Means of draining and venting	2.5
5.1 ; 6.1.3 ; 6.6.1 ; 7	Protection against exceeding the allowable limits	2.10
4.3 ; 6.6	Safety accessories	2.11.1
6.1 ; 6.2.2 ; 6.2.3 ; 6.3.2 ; 6.4.2 ; 6.6	Pressure limitation	2.11.2 ; 7.3
6.6 ; 9.2	Temperature monitoring devices	2.11.3
6.2.3 ; 7.2	External fire	2.12
4.3 ; 6.6.3	Operating instructions	3.4

Bibliography

The following standards are those which can be useful in this field but are not referred to in the text:

EN 292-1:1991, *Safety of machinery – Basic concepts, general principles of design – Part 1: Basic terminology, methodology.*

EN 292-2:1995, *Safety of machinery – Basic concepts, general principles of design – Part 2: Technical principles and specification.*

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