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Safety devices for protection against excessive pressure —

Part 9:
Application and installation of safety devices excluding stand-alone bursting disc safety devices

Dispositifs de sécurité pour protection contre les pressions excessives —

Partie 9: Application et installation des dispositifs de sécurité autres que les dispositifs à disque de rupture installés seuls

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Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 4126-9 was prepared by Technical Committee ISO/TC 185, *Safety devices for protection against excessive pressure*.

ISO 4126 consists of the following parts, under the general title *Safety devices for protection against excessive pressure*:

— *Part 1: Safety valves*

— *Part 2: Bursting disc safety devices*

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

— *Part 4: Pilot-operated safety valves*

— *Part 5: Controlled safety pressure relief systems (CSPRS)*

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

— *Part 7: Common data*

— *Part 9: Application and installation of safety devices excluding stand-alone bursting disc safety devices*

— *Part 10: Sizing of safety valves and connected inlet and outlet lines for gas/liquid two-phase flow*

Introduction

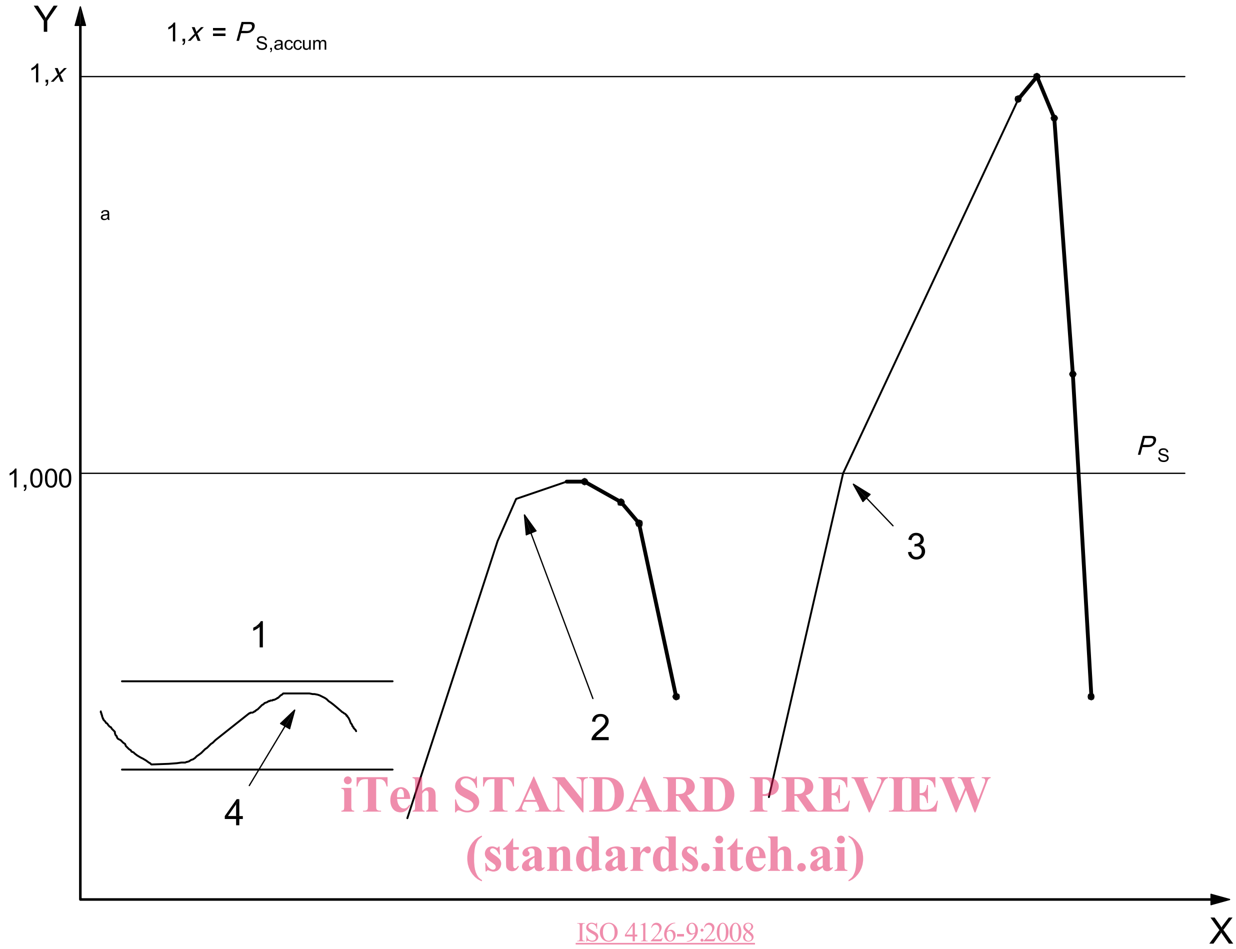
A safety device or system is the final element to protect pressure equipment from exceeding its allowable limits. Regulating and/or monitoring devices are not ultimate safety devices in the meaning of this International Standard. They become active in advance of an ultimate safety device (see Figure 1).

It is important to consider not only the pressure-relieving device but also the whole of the equipment protected, so as not to reduce the relieving capacity or adversely affect the proper operation of the pressure-relieving devices, in order to ensure that the relieving pressure is not exceeded. The value of the relieving pressure is 1,x times the maximum allowable pressure, P_S, where x is defined by a directive or national regulation. Operating problems can occur in pressure relief because of the selection of an inappropriate device or because a correctly selected device is adversely affected by improper handling, wrong installation or lack of maintenance.

In some cases, it can be necessary to determine the basic details of the equipment protected so as to ensure that the maximum relieving pressure is not exceeded.

NOTE 1 There can be requirements in a number of regulations to be respected and it is the responsibility of the user of this part of ISO 4126 to ensure compliance with these requirements. This part of ISO 4126 is also intended to draw attention to subjects that are not within its scope, but which are relevant to safety devices.

NOTE 2 To cover the essential requirements of the various regulations, a safety device needs to incorporate a whole range of products. Many of these products are covered by International Standards, but there are others that will either never be standardized or that will not be standardized within the foreseeable future. Where standards have already been produced, where work is known to be proceeding or where there is the intention of producing an applicable standard, reference is made to the standard concerned. Where there is no standard to which to refer, this part of ISO 4126 merely specifies the essential requirements of the device.



Key

X time

Y pressure

1 reaction of regulating control system

2 reaction of monitoring system

3 reaction of safety system

4 normal operating range

P_S maximum allowable pressure

$P_{S,accum}$ maximum allowable accumulated pressure ($P_S \times 1,x$)

a No continuous operation in this zone.

Figure 1 — Diagram of typical system relationship

Safety devices for protection against excessive pressure —

Part 9: Application and installation of safety devices excluding stand-alone bursting disc safety devices

1 Scope

This part of ISO 4126 covers the application and installations of safety devices such as safety valves, safety valves and bursting disc safety devices in combination, pilot-operated safety valves and controlled safety pressure-relief systems for the protection of pressure equipment. ISO 4126-6 covers the selection, application and installation of bursting disc safety devices.

This part of ISO 4126 describes the normative requirements for applications and installations of safety devices to protect static pressure equipment. The information contained in this part of ISO 4126 assumes single-phase flow of the fluid discharged from the safety device. ISO 4126-10 provides guidance specific to two-phase flow conditions.

Equipment connected together in a system by piping of adequate capacity, which is free from potential blockages and does not contain any valve that can isolate any part, can be considered to be a safety system for the application of pressure relief.

This part of ISO 4126 does not deal with other safety devices, such as safety related monitoring, control and regulation devices and other limiting devices allowed by some national regulations.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

3 Terms and definitions

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

3.1
safety device
device that serves as the ultimate protection to ensure that the maximum allowable accumulated pressure is not exceeded

EXAMPLE Safety valves, bursting disc safety devices, etc.

3.2
safety system
system including the safety devices and the interconnections between the equipment to be protected and any discharge connection to the nearest location of a safe disposal place

NOTE This location can either be an atmospheric outlet or the connection into a safe collecting system or flare.

3.3
fail-safe
status such that the pressure equipment remains in a safe condition in case of failure of any safety system component or energy source

3.4
self-diagnosis
regular and automatic determination that all chosen components of a safety system are capable of functioning as required

3.5
redundancy
provision of more than one device or system such that the necessary function will still be provided in case of failure of one or more of these devices

3.6
independence
ability to function as required without interference from other equipment

3.7
hazard
potential source of harm

NOTE 1 The term “hazard” can be qualified in order to define its origin or the nature of the expected harm (see ISO/IEC Guide 51).

NOTE 2 Harm is the physical injury or damage to the health of people, or damage to property or to the environment.

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

NOTE See ISO/IEC Guide 51.

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

NOTE See ISO/IEC Guide 51.

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

NOTE See ISO/IEC Guide 51.

3.11
risk assessment
overall process of risk analysis and risk evaluation

NOTE See ISO/IEC Guide 51.

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

3.13
pressure limiter
device which ensures that the permitted maximum allowable pressure is not exceeded during continuous operation

NOTE It activates the means for correction, or provides for shutdown or shutdown and lockout.

3.14
safety
freedom from unacceptable risk

NOTE See ISO/IEC Guide 51.

3.15
maximum allowable pressure
P_{S}
maximum pressure for which the equipment is designed, as specified by the manufacturer

3.16
maximum/minimum allowable temperature
T_{S}
maximum/minimum temperatures for which the equipment is designed, as specified by the manufacturer

3.17
accumulated pressure
pressure in the equipment to be protected which can exceed maximum allowable pressure for a short duration during the operation of safety devices

3.18
maximum allowable accumulated pressure
$P_{\mathrm{S,accum}}$
maximum allowable value of the accumulated pressure in the equipment being protected which is fixed by national codes, regulations or directives

4 Risk consideration

4.1 All service conditions shall be considered when selecting the most appropriate safety concept, in order to ensure safe operation of the pressure equipment. This requires a realistic assessment of risk by means of risk analysis and risk evaluation.

4.2 Risk analysis involves, for example:

a) determination of the boundaries of the pressure equipment, including:

   1) maximum quantity of fluid to be discharged,

   2) intended use,

   3) reasonably foreseeable misuse,

   4) influences of sizing and flow of the safety device on operational reliability and performance of the safety system;

b) identification of potential hazards and estimation of the risk.

4.3 In particular, the risk analysis shall take in consideration the following:

a) equipment connected together by piping of adequate capacity, which is free from potential blockages and does not contain any valve that can isolate any part, may be considered as a system of pressurized components for the application of pressure relief;

b) where a component failure during operation is foreseen and would cause the pressure of fluid in the vessel to exceed the maximum allowable pressure, this failure shall be considered when evaluating the total capacity of the safety device(s);

c) vessels that are to operate completely filled with liquid and can be isolated shall be equipped with a safety device, unless otherwise protected against excessive pressure;

d) in cases where excessive vacuum conditions can occur and the vessel is incapable of withstanding such conditions, a vacuum safety device shall be fitted to allow a suitable fluid to enter the vessel automatically, so as to prevent the allowable vacuum being exceeded.

4.4 Examples of foreseeable failure include

a) failure of a heating coil, and

b) tube failure in a shell and tube heat exchanger. The normal practice is to design the protective device, taking into account the breakage of one tube in a heat exchanger with flow occurring from both ends of the tube.

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

NOTE It is advisable that the manufacturer and the user consider the most onerous conditions that can exist for pressure and temperature within the allowable limits.

4.6 Risk analysis and risk evaluation produce the basic information that is needed for the risk assessment to design correctly the pressure equipment and to select the most efficient safety device(s). 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) prevent the danger from misuse.

The manufacturer shall inform the user of residual hazards and indicate the appropriate special measures for the particular case.

5 Pressure limitation

5.1 General

5.1.1 Safety devices shall become operational such that during the period in which the devices operate, the pressure in the equipment shall not exceed the maximum allowable accumulated pressure.

5.1.2 During normal operation of the equipment, the pressure shall be limited to the maximum allowable pressure at the appropriate temperature.

5.1.3 Where, under reasonably foreseeable service conditions, the internal pressure can exceed the maximum allowable pressure, the pressure equipment shall be protected by means of at least one safety device of adequate capacity and capability.

5.1.4 The safety device(s) shall be sized to have the required discharge capacity at a pressure not higher than the maximum allowable accumulated pressure.

5.1.5 When calculating the capacity of a safety device, the actual pressure and temperature of the relieved fluid shall be used. The effect of back pressure on the discharge capacity shall also be taken into account.

5.1.6 Oversizing of a safety device could cause secondary problems (e.g. too much fluid released, instability). The selection of type, number, size or combination of safety devices shall be suitable and reliable for the process of pressure equipment to be protected. For the calculation of the pressure losses of the inlet and the outlet lines, see Clauses 6 and 7.

If more than one safety device is installed, a possible interaction shall be taken into account, i.e.:

— when connected to the same discharge system, back pressure may affect the opening of a safety device when others are already discharging;

— dynamic effects (e.g. mechanical forces, flow changes).

5.2 Setting of safety devices

5.2.1 Safety devices shall have a set pressure not exceeding the maximum allowable pressure (P_S) of the equipment to be protected, except as permitted in 5.2.2 and 5.2.3.

5.2.2 If the capacity is provided by more than one safety device, only one of the devices needs to be set at a pressure not exceeding P_S. The other device(s) may be set at a pressure not more than 5 % in excess of P_S (see example in Annex B). In these cases, it is necessary to use safety devices with certified overpressure lower than the maximum allowable accumulated pressure, in order to meet the requirements of 5.1.4. In some cases (e.g. fire), national codes may permit set pressures in excess of $1{,}05 \times P_S$.

5.2.3 If allowed by national regulations or directives, the safety device set pressure may be above P_S, but not exceeding $1{,}05 \times P_S$, provided that an additional pressure limiter is fitted to ensure that the permitted P_S is not exceeded during continuous operation. In these cases, it is necessary to use safety devices with certified overpressure lower than the maximum allowable accumulated pressure in order to meet the requirements of 5.1.4.

5.2.4 The pressure at which a safety device is set to operate shall take into account the effect of static head, of superimposed back pressure and whether this is constant or variable. The effect of static head shall not result in a set pressure above P_S.

5.2.5 In cases requiring safety devices certified for liquid service with an overpressure exceeding the difference between P_S and the maximum allowable accumulated pressure, the set pressure shall be set at a lower value than P_S in order to meet the requirements of 5.1.4.

NOTE Similar considerations can apply to vapour service at low pressure.

5.2.6 In the case of re-closing safety devices, the reseating pressure shall be above the normal operating pressure of the system (see Figures A.1 and A.2).

5.2.7 In the case of spring loaded valves, the operating pressure should be set as low as practical below the set pressure. Safety valves are normally leak tested at 10 % below set pressure and differentials between set and operating pressure should take this into account.

6 Inlet line

6.1 The inlet line shall be as short as practical in order to avoid the negative influence of dynamic effects and pressure losses.

The inlet line from the equipment to be protected to the safety device may affect the performance of the safety device (e.g. stability and capacity).

The nominal size of the inlet line shall not be less than that of the safety valve inlet, stand alone or in combination.

6.2 Unless otherwise specified by national codes or regulations, the inlet line shall be so designed that the total pressure drop to the valve inlet does not exceed 3 % of the set pressure of the safety device, or one third of the blowdown, whichever is less. For built up back pressure, see Clause 7.

NOTE This is based on the correlation of the settled pressure loss in the inlet line of 3 % relative to the standard blowdown of 10 %, which is approximately one third.

In all cases, the difference between blowdown and pressure drop to the valve inlet shall be at least 2 % of the set pressure.

6.3 Unless otherwise specified by national codes or regulations, the total inlet pressure drop (difference of stagnation pressures, i.e. non-recoverable losses) is calculated using the actual flowing capacity, which is the capacity of the safety device calculated using the certified coefficient of discharge, divided by the derating factor 0,9. The pressure drop shall include the effects of isolating valves, fittings and bursting disc safety devices.

The inlet pressure drop calculation shall not be done by using the required capacity of a safety valve.

NOTE It is advisable that isolating valves and fittings in the inlet piping to a safety device be of the full bore type. Pressure losses can be reduced by avoiding sharp edges in the pipe work or by enlarging the diameter.

6.4 In some installed configurations of pilot operated safety valves (POSV) and controlled safety pressure relief system (CSPRS), the pressure loss may exceed 3 %. Further analysis of the valve performance should be carried out to ensure the stable operation of the safety device. This analysis may result in the use of, for example, remote sensing lines, lowered closing sensing pressure.

If the pressure loss exceeds 3 %, it shall be taken into account in the calculation of mass flow or flow area.

For calculations of pressure loss, see Annex C.

7 Outlet line

7.1 Consideration shall be given to the possible effect of back pressure on the safety device set pressure, its discharge capacity and its operating characteristics. This back pressure may be built-up back pressure or superimposed back pressure, or created by a bursting disc safety device installed downstream from a safety valve.

The allowable back pressure, which is the sum of the built-up back pressure and the superimposed back pressure, is typically specified by the valve manufacturer or national code or regulation.

NOTE This allowable back pressure is usually given as a percentage of the difference between the set pressure and the superimposed back pressure. For example, if the built-up back pressure is to be limited to 15 %,

$$\frac{P_{\mathrm{b}} - P_{\mathrm{u}}}{P_{\mathrm{set}} - P_{\mathrm{u}}} = 0{,}15$$

