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**Application and installation of
safety devices excluding
stand-alone bursting disc safety
devices**

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Foreword

This Japanese Industrial Standard has been established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by Japan Valve Manufacturers' Association (JVMA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act.

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NOTE Based on Article 9 of the Supplementary Provisions to the Unfair Competition Prevention Act etc., any submission of proposal, or employment of procedures such as deliberation by the Japanese Industrial Standards Committee under the previous Industrial Standardization Act shall be deemed to have been conducted pursuant to the provision of Article 12, paragraph (1) of the revised Industrial Standardization Act.

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

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 4126-9:2008**, Edition 1, with some modifications of the technical contents, in order to reflect the actual situation in Japan.

The dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies the requirements for 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. For the application and installation of bursting disc safety devices, **JIS B 8226-3** applies.

This Standard describes the normative requirements for applications and installations of safety devices to protect static pressure equipment. The information contained in this Standard assumes single-phase flow of the fluid discharged from the safety device. **JIS B 8227** 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 Standard 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.

NOTE 1 National regulations described in this Standard indicate the High Pressure Gas Safety Act, the Electricity Business Act, the Gas Business Act and the Industrial Safety and Health Act in Japan.

NOTE 2 The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

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

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standards and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 0100 *Glossary of terms for valves*

JIS B 8210 *Safety devices for protection against excessive pressure—Safety valves*

JIS B 8225 *Safety valves—Measuring methods for coefficient of discharge*

JIS B 8226-1 *Bursting disc safety devices—Part 1: General*

JIS B 8226-2 *Bursting disc safety devices—Part 2: Combination with safety valve*

JIS B 8226-3 *Bursting disc safety devices—Part 3: Application, selection and installation*

NOTE Corresponding International Standard: ISO 4126-6 *Safety devices for protection against excessive pressure—Part 6: Application, selection and installation of bursting disc safety devices* (MOD)

JIS B 8227 *Sizing of safety valves for gas/liquid two-phase flow*

JIS Z 8051 *Safety aspects—Guidelines for their inclusion in standards*

JIS Z 8209 *Symbols for piping drawings of chemical plants*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS B 0100**, **JIS B 8210**, **JIS B 8225**, **JIS B 8226-1**, **JIS B 8226-2**, **JIS B 8226-3**, **JIS Z 8051** and **JIS Z 8209**, and the following 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 **3.2** of **JIS Z 8051**).

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 **3.9** of **JIS Z 8051**.

3.9

risk analysis

systematic use of available information to identify hazards and to estimate the risk

NOTE See **3.10** of **JIS Z 8051**.

3.10

risk evaluation

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

NOTE See **3.12** of **JIS Z 8051**.

3.11

risk assessment

overall process of risk analysis and risk evaluation

NOTE See **3.11** of **JIS Z 8051**.

3.12

reliability

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

NOTE The wording of definition differs from that in **JIS Z 8115** and **3.2** of **JIS B 9700**.

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 **3.14** of **JIS Z 8051**.

3.15

maximum allowable pressure, P_s

maximum pressure for which the equipment is designed, as specified by the manufacturer of the pressure equipment

3.16

maximum/minimum allowable temperature, T_s

maximum/minimum temperatures for which the equipment is designed, as specified by the manufacturer of the pressure equipment

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, $P_{s,accum}$

maximum allowable value of the accumulated pressure in the equipment being protected which is fixed by national codes, regulations or directives

3.19

over pressure

pressure increase exceeding the set pressure of the safety valve

NOTE Over pressure is usually given as a percentage of a set pressure.

3.20

back pressure

pressure that exists at the outlet of a safety valve as a result of the pressure in the discharge system

NOTE The back pressure is the sum of the superimposed and built-up back pressures.

3.21

built-up back pressure

pressure existing at the outlet of a safety valve caused by flow through the valve and the discharge system

3.22

superimposed back pressure

pressure existing at the outlet of a safety valve before the safety valve functions

NOTE This pressure is derived from the pressure existing in the discharge system from other pressure sources.

3.23

allowable accumulation

allowable value of over pressure

NOTE Allowable accumulation is usually given as a percentage of a set pressure.

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 of the safety device, 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 allowable accumulation, 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 not less than 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 allowable accumulation 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 gas/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 Annex A).

5.2.7 In the case of spring loaded valves, the operating pressure should usually 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.

NOTE The pressure decreases dynamically as a result of acceleration of the fluid in the inlet line when the safety valve is opened.

6.2 Unless otherwise specified by national codes or regulations, the inlet line should 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 In all cases, the difference between blowdown and pressure drop to the valve inlet should 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 (see Table C.3) or by enlarging the diameter.

6.4 In some installed configurations of pilot operated safety valves (POSV) and controlled safety pressure relief system (CSPRS, see **ISO 4126-5**), the pressure loss may exceed 3 % of the set pressure. 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 % of the set pressure, 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 %,

$$\frac{P_b - P_u}{P_{\text{set}} - P_u} = 0.15$$

where, P_b : back pressure

P_u : superimposed back pressure

P_{set} : set pressure

7.2 Unless otherwise specified by national codes or regulations, the outlet pressure is calculated using the flowing capacity, which is the capacity of the safety device calculated using the certified coefficient of discharge, divided by the derating factor 0.9. This calculation shall include the effects of isolating valves, fittings and bursting disc safety devices.

NOTE The flowing capacity is usually greater than the required capacity.

7.3 The influence of the back pressure may be reduced by the use of safety valves fitted with balanced bellows. If the superimposed back pressure on an unbalanced spring loaded safety valve is constant, the valve shall be set using the cold differential test pressure (see **JIS B 8210**). If the superimposed back pressure is variable, its effects on the set pressure of the safety device may be minimized using balanced bellows.

NOTE For further information on calculating built-up back pressures and a method for designing outlet pipe systems, see Annex D. Graphical solutions are provided for allowable built-up back pressures of 10 %, 15 %, 20 %, 30 % and 40 %.

7.4 The outlet line shall be as short as practicable and have a bore at least as large as the valve outlet.

Outlet lines should be designed to be free draining from the safety device to any collection system. For open or closed disposal systems, if the installation is such that liquid can collect on the discharge side of the valve disc, the valve or the outlet line shall be fitted with an adequate drain at the lowest point to prevent liquid accumulation, and precautions shall be taken (where necessary) to prevent freezing.

7.5 To prevent excessive reaction stresses being transmitted to the safety device, the outlet line shall be securely anchored and adequately supported. The system shall be sufficiently flexible to accommodate temperature changes.