



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS B 8210 : 2017

(JBA/JSA)

**Safety devices for protection
against excessive pressure—
Safety valves**

ICS 13.240;27.060.30

Reference number : **JIS B 8210 : 2017 (E)**

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Date of Establishment: 1950-09-18

Date of Revision: 2017-11-25

Date of Public Notice in Official Gazette: 2017-11-27

Investigated by: Japanese Industrial Standards Committee
Standards Board for ISO area
Technical Committee on Industrial Machinery

JIS B 8210:2017, First English edition published in 2018-05

Translated and published by: Japanese Standards Association
Mita MT Building, 3-13-12, Mita, Minato-ku, Tokyo, 108-0073 JAPAN

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Printed in Japan

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Health, Labour and Welfare and the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Boiler Association (JBA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently **JIS B 8210**:2009 is replaced with this Standard.

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Safety devices for protection against excessive pressure—Safety valves

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 4126-1:2013** (Edition 3) and its Amendment 1:2016, and **ISO 4126-7:2013** (Edition 2) and its Amendment 1:2016. Some of the technical contents of the International Standards have been modified to bring them into accordance with needs and circumstances unique to Japan. The amendments to the International Standards have been compiled into this Standard.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JB.

1 Scope

This Standard specifies requirements for full bore safety valves with a set pressure of 0.1 MPa (gauge pressure)¹⁾ and above and with a throat diameter of 7 mm and above, and curtain area restricted safety valves with a valve seat opening diameter of 15 mm and above. This Standard is not applicable to pilot-operated safety valves, or those safety valves used for pressure vessels for refrigeration.

This is a product standard, and is not applicable to applications of safety valves.

Note ¹⁾ Pressure requirements in this Standard are given in either absolute pressure or gauge pressure, whichever is appropriate for the particular requirement. Absolute pressures are given in Pa, with the indication “(absolute)” attached after the unit where clear distinction is necessary. All gauge pressures are given in Pa with the indication “(gauge)” attached after it.

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

ISO 4126-1:2013 *Safety devices for protection against excessive pressure—Part 1: Safety valves* and Amendment 1:2016

ISO 4126-7:2013 *Safety devices for protection against excessive pressure—Part 7: Common data* and Amendment 1:2016 (Overall evaluation: MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard 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 0203	<i>Taper pipe threads</i>
JIS B 0403	<i>Castings—System of dimensional tolerances and machining allowances</i>
JIS B 0405	<i>General tolerances—Part 1: Tolerances for linear and angular dimensions without individual tolerance indications</i>
JIS B 2001	<i>Nominal size and bore of valves</i>
JIS B 2220	<i>Steel pipe flanges</i>
JIS B 2239	<i>Cast iron pipe flanges</i>
JIS B 2240	<i>Copper alloy pipe flanges</i>
JIS B 8201	<i>Stationary steel boilers—Construction</i>
JIS B 8225	<i>Safety valves—Measuring methods for coefficient of discharge</i>
JIS B 8226-2	<i>Bursting disc safety devices—Part 2: Combination with safety valve</i>
JIS B 8227	<i>Sizing of safety valves for gas/liquid two-phase flow</i>
JIS B 8265	<i>Construction of pressure vessel—General principles</i>
JIS B 8267	<i>Construction of pressure vessel</i>
JIS G 0581	<i>Methods of radiographic examination for steel castings</i>
JIS G 5501	<i>Grey iron castings</i>
JIS G 5502	<i>Spheroidal graphite iron castings</i>
JIS G 5705	<i>Malleable iron castings</i>
JIS H 5120	<i>Copper and copper alloy castings</i>
JIS Z 2343-1	<i>Non-destructive testing—Penetrant testing—Part 1: General principles—Method for liquid penetrant testing and classification of the penetrant indication</i>
JIS Z 3104	<i>Methods of radiographic examination for welded joints in steel</i>
JIS Z 3106	<i>Methods of radiographic examination for welded joints in stainless steel</i>

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS B 0100**, and the following apply.

3.1

safety valve

valve which automatically, without the assistance of any energy other than that of the fluid concerned, discharges a quantity of the fluid so as to prevent a predetermined safe pressure from being exceeded, and which is designed to re-close and prevent further flow of fluid after normal pressure conditions of service have been restored

NOTE 1 The valve can be characterized either by pop action (rapid opening) or by opening in proportion (not necessarily linear) to the increase in pressure over the set pressure.

NOTE 2 Safety valves are classified into pilot-operated valves and valves with other mechanisms; the safety valves defined in **3.2** to **3.4** all fall under the category of the latter.

3.2

direct loaded safety valve

safety valve in which the loading due to the fluid pressure underneath the valve disc is opposed only by a direct mechanical loading device such as a weight, lever and weight, or spring²⁾

Note ²⁾ A safety valve using a spring as a loading device is referred to as the spring loaded safety valve.

3.3

assisted safety valve

safety valve which, by means of a powered assistance mechanism, may additionally be lifted at a pressure lower than the set pressure and will, even in the event of failure of the assistance mechanism, comply with all the requirements for safety valves given in this Standard

3.4

supplementary loaded safety valve

safety valve which has, until the pressure at the inlet to the safety valve reaches the set pressure, an additional force which increases the sealing force

NOTE This additional force (supplementary load), which may be provided by means of an extraneous power source, is reliably released when the pressure at the inlet of the safety valve reaches the set pressure. The amount of supplementary loading is so arranged that if such supplementary loading is not released, the safety valve will attain its certified capacity at a pressure not greater than 1.1 times the maximum allowable pressure of the equipment to be protected.

3.5

curtain area restricted safety valve

safety valve of which the lift is $\frac{1}{40}$ or over to and excluding $\frac{1}{4}$ the seat diameter, and of which the seat flow area (curtain area) is the smallest of all flow areas with the valve disc opened

3.6

full bore safety valve

safety valve capable of obtaining a lift where the seat flow area becomes sufficiently larger than the area of the throat

3.7

set pressure

predetermined pressure at which a safety valve under operating conditions commences to open

NOTE It is the gauge pressure measured at the valve inlet at which the pressure forces tending to open the valve for the specific service conditions are in equilibrium with the forces retaining the valve disc on its seat.

It is a pressure value prescribed in designing of a valve, which then is verified by type tests or product inspection to be within a permissible range.

3.8

maximum allowable pressure (PS)

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

3.9

overpressure

pressure increase over the set pressure

NOTE Overpressure is usually expressed as a percentage of the set pressure.

3.10

reseating pressure; closing pressure

value of the inlet static pressure at which the disc re-establishes contact with the seat or at which the lift becomes zero

3.11

cold differential test pressure (CDTP)

inlet static pressure at which a safety valve is set to commence to open on the test bench

NOTE This test pressure includes corrections for service conditions, e.g. back pressure and/or temperature.

3.12

relieving pressure; flow rating pressure

the inlet side pressure at the time of calculating the discharge capacity of a safety valve, which is the sum of the set pressure and the overpressure

NOTE For calculating the certified capacity, the sum of set pressure and allowable overpressure is used.

3.13

relieving temperature

the inlet side temperature at the time of calculating the discharge capacity of a safety valve

3.14

opening pressure; popping pressure

pressure at the inlet side when the safety valve rapidly opens (pops)

NOTE Pop action means the action of the safety valve to blow out the inside fluid when the lift increases instantaneously.

3.15

start-to-discharge pressure; start-to-leak pressure

inlet side pressure when the pressure increase at the inlet side has caused a minor volume of outflow to be detected at the discharge side

NOTE A minor volume of outflow, in this case, is such an outflow as clearly detectable by vision or hearing, in the case of steam, and by hearing or by means such as applying a soap water over the exit outlet within the allowable limit of start-to-discharge pressure, in the case of gas and liquid. It does not include the outflow due to valve seat leakage.

3.16

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.

3.17

built-up back pressure

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

3.18

superimposed back pressure

pressure existing at the outlet of a safety valve at the time when the device is required to operate

NOTE It is the result of pressure in the discharge system from other sources.

3.19

balanced bellows

device which minimizes the effect of back pressure on the set pressure and/or the operation of a safety valve

3.20

blowdown

difference between set and reseating pressures

When using the opening pressure or start-to-discharge pressure and reseating pressure measured in the product inspection, blowdown may be the difference between opening pressure and reseating pressure or between start-to-discharge pressure and reseating pressure.

NOTE Blowdown is normally stated as a percentage of set pressure (start-to-discharge pressure or opening pressure, when using the measured opening pressure or start-to-discharge pressure) except where the measured opening pressure or start-to-discharge pressure is less than 0.3 MPa (gauge), in which case the blowdown is expressed in MPa.

3.21

lift

actual travel of the valve disc away from the closed position

3.22

flow area

minimum cross-sectional flow area (see Figure JA.1) between inlet and seat which is used to calculate the theoretical discharge capacity (see Annex A) and certified capacity with no deduction for any obstruction

3.23

throat area; bore area

flow area calculated using the throat diameter

3.24

seat flow area; curtain area

flow area of the cylindrical or conical shaped opening between the valve disc and the valve seat surface obtained by the lift of the valve disc

3.25

flow diameter

diameter corresponding to the flow area

3.26

seat diameter

inside diameter of the contact face of the valve disc with the valve seat (see Figure JA.1)

3.27

throat diameter; bore diameter

inside diameter of the flow at its narrowest portion from the fluid intake opening to the valve seat surface (see Figure JA.1)

3.28

theoretical discharge capacity

calculated capacity expressed in mass or volumetric units of a theoretically perfect nozzle having a cross-sectional flow area equal to the flow area of a safety valve

3.29

coefficient of discharge

value of actual flowing capacity (from tests) divided by the theoretical flowing capacity (from calculation)

3.30

certified de-rated coefficient of discharge

coefficient to be used for the calculation of certified capacity, which is the product of coefficient of discharge and de-rated coefficient

De-rated coefficient is the ratio of the certified de-rated coefficient of discharge to the coefficient of discharge, which is generally set to be 0.9 or under.

3.31

certified (discharge) capacity

discharge capacity used for selection of safety valves, which shall be in accordance with one of the following:

- a) measured discharge capacity $\times$ de-rated coefficient;
- b) theoretical discharge capacity $\times$ coefficient of discharge $\times$ de-rated coefficient;
- c) theoretical discharge capacity $\times$ certified de-rated coefficient of discharge;
- d) discharge capacity determined by the specification of Annex JA.

3.32

nominal size (DN)

alphanumeric designation of size that is common for components used in a piping system, used for reference purposes, comprising a dimensionless number³⁾ having an indirect correspondence to the physical size of the bore or outside diameter of the component end connection, followed by the letter A or B

The nominal size of a safety valve shall be the nominal diameter at the inlet side, for which **JIS B 2001** shall be normally applied.

Note ³⁾ The dimensionless number does not represent a measurable value and is not used for calculation purposes.

3.33

steam quality, dryness fraction

measure of relative vapour/liquid content of a steam quantity or stream, expressed as the mass fraction (vapour mass/vapour mass + liquid mass) or percentage of vapour

4 Symbols and units

Symbols and units are as follows.

K_d : coefficient of discharge⁴⁾

K_{dr} : certified de-rated coefficient of discharge ($\leq K_d \times 0.9$)⁴⁾

n : number of tests

q_m : theoretical specific discharge capacity [kg/(h · mm²)]

q'_m : specific discharge capacity determined by tests [kg/(h · mm²)]

Note ⁴⁾ K_d and K_{dr} are expressed to the third decimal place.

5 Design

5.1 General

The general requirements for design shall be as follows.

- a) The design shall incorporate guiding arrangements necessary to ensure consistent operation and seat tightness.

- b) The seat of a safety valve, other than when it is an integral part of the valve shell, shall be fastened securely to prevent the seat from becoming loose in service.
- c) In the case of valves where the lift can be reduced to conform to the required discharge capacity, restriction of the lift shall not interfere with the operation of the valve. The lift restricting device shall be designed so that, if adjustable, the adjustable feature can be mechanically locked and access sealed. The lift restricting device shall be installed and sealed according to the design of the valve manufacturer.

Valve lift shall not be restricted to a value less than 30 % of unrestricted lift or 1.0 mm, whichever is the greater.

- d) Means shall be provided to lock and/or to seal all external adjustments in such a manner so as to prevent or reveal unauthorized adjustments of the safety valve.
- e) Safety valves for toxic or flammable fluids shall be of the closed bonnet type to prevent leakage to atmosphere, or if the bonnet is vented, the fluids shall be guided to and disposed of in a safe place.
- f) Provision, such as a drain pipe, shall be made to prevent liquid collection on the discharge side of the safety valve shell.
- g) The design stress of outer shell construction (pressure-retaining shells)⁵⁾ shall not exceed the permitted value specified in **JIS B 8201**, **JIS B 8265**, or **JIS B 8267**. Design stress criteria other than these may be used upon agreement between the purchaser and the manufacturer.

Note ⁵⁾ The outer shell construction (pressure-retaining shells) does not include valve disc.

- h) The materials for adjacent slidings surface such as guide(s) and disc/disc holder/spindle shall be selected to ensure corrosion resistance and to minimize wear and avoid sticking.
- i) The materials for the seat and disc of safety valves shall be selected to ensure resistance to metallic bonding between these two surfaces in order to prevent an increase of set pressure.
- j) Sealing elements which may adversely affect the operating characteristics by frictional forces are not permitted.
- k) Easing gear shall be provided when specified.

This gear shall enable manual lifting of the valve disc when the pressure is 75 % or over of the set pressure, and when it is released, shall allow the valve disc to return to the close position.

- l) Safety valves shall be constructed so that breakage of any part, or failure of any device, will not obstruct free and full discharge through the valve.
- m) Safety valves with a set pressure of over 3 MPa (gauge) intended for steam or for fluid of temperature exceeding 235 °C shall be so constructed that the spring is not directly exposed to the discharged fluid.

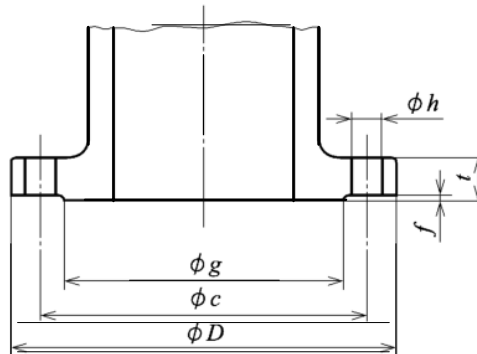
- n) The screw-in type safety-valve shall be provided with faces that can be gripped by a spanner at the time of installation.
- o) The inclination of the contacting face of the valve disc with the valve seat, with respect to the valve axis, should preferably be 45° (for conical seat) or 90° (for flat seat).

5.2 Valve end connections

The valve end connections shall be as follows.

- a) Thread shape and size of screw joint used at the end connections of safety valve shall be in accordance with **JIS B 0203**, and its material, in accordance with Clause 6.
- b) Flange for flange joint shall be in accordance with **JIS B 2220**, **JIS B 2239** or **JIS B 2240** and the following.
 - 1) For full bore safety valve for steam boiler, shapes and dimensions of connecting flanges shall be in accordance with Table 1, which factors in the reaction force due to discharge, or those shapes and dimensions providing a strength equal or superior thereto.
 - 2) Full bore or curtain area restricted safety valves, excluding full bore safety valves for steam boilers, may have flanges with a larger thickness and/or of a larger nominal size if their flange strength need to be increased as appropriate for the reaction force due to discharge.
 - 3) In the case of 1) or 2) above, the materials shall be in accordance with Clause 6, and **JIS B 2220** or **JIS B 2239**.
- c) Valve end connections other than specified in a) or b) shall be as agreed between the purchaser and the manufacturer.

Table 1 Shapes and dimensions of connecting flanges for full bore safety valve for steam boiler



Unit: mm

Nominal pressure of flange (symbol)	Nominal size (A)	Flange				Bolt hole			Bolt thread size
		D	t (min.)	f	g	c	Number of holes	h	
10 K	20	125	18	1	67	90	4	19	M 16
	25	135	20	2	76	100	4	19	M 16
	32	140	20	2	81	105	4	19	M 16
	40	155	20	2	96	120	8	19	M 16
	50	175	22	2	116	140	8	19	M 16
	65	200	24	2	132	160	8	23	M 20
	80	210	24	2	145	170	8	23	M 20
	(90)	225	26	2	160	185	8	23	M 20
	100	270	26	2	195	225	8	25	M 22
	125	305	28	2	230	260	12	25	M 22
	150	350	30	2	275	305	12	25	M 22
	200	430	34	2	345	380	12	27	M 24
16 K	20	125	20	1	67	90	4	19	M 16
	25	135	20	2	76	100	4	19	M 16
	32	140	22	2	81	105	4	19	M 16
	40	155	22	2	96	120	8	19	M 16
	50	175	24	2	116	140	8	19	M 16
	65	200	26	2	132	160	8	23	M 20
	80	210	28	2	145	170	8	23	M 20
	(90)	225	28	2	160	185	8	23	M 20
	100	270	30	2	195	225	8	25	M 22
	125	305	32	2	230	260	12	25	M 22
	150	350	34	2	275	305	12	25	M 22
	200	430	38	2	345	380	12	27	M 24

Table 1 (concluded)

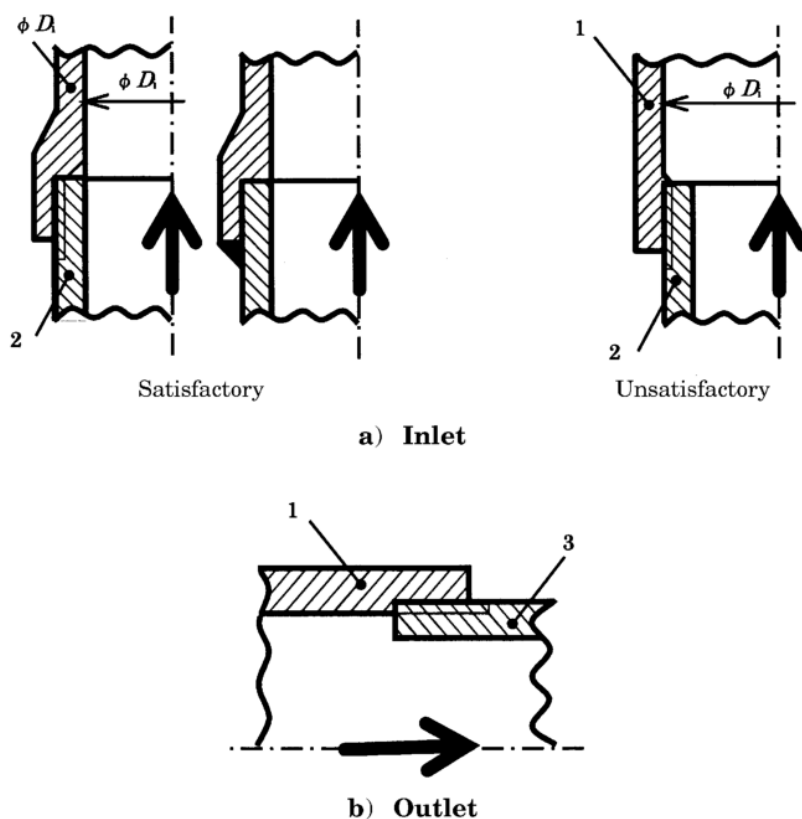
Unit: mm

Nominal pressure of flange (symbol)	Nominal size (A)	Flange				Bolt hole			Bolt thread size
		<i>D</i>	<i>t</i> (min.)	<i>f</i>	<i>g</i>	<i>c</i>	Number of holes	<i>h</i>	
20 K	20	130	20	1	70	95	4	19	M 16
	25	140	22	2	80	105	4	19	M 16
	32	160	22	2	90	120	4	23	M 20
	40	165	22	2	105	130	8	19	M 16
	50	200	26	2	130	160	8	23	M 20
	65	210	28	2	140	170	8	23	M 20
	80	230	30	2	150	185	8	25	M 22
	(90)	240	32	2	160	195	8	25	M 22
	100	275	36	2	195	230	8	25	M 22
	125	325	38	2	235	275	12	27	M 24
	150	370	42	2	280	320	12	27	M 24
	200	450	48	2	345	390	12	33	M 30 × 3
30 K	20	130	22	1	70	95	4	19	M 16
	25	140	24	2	80	105	4	19	M 16
	32	160	24	2	90	120	4	23	M 20
	40	165	26	2	105	130	8	19	M 16
	50	200	30	2	130	160	8	23	M 20
	65	210	32	2	140	170	8	23	M 20
	80	230	34	2	150	185	8	25	M 22
	(90)	250	36	2	165	205	8	25	M 22
	100	300	40	2	200	250	8	27	M 24
	125	355	44	2	240	295	12	33	M 30 × 3
	150	405	50	2	290	345	12	33	M 30 × 3
	200	475	56	2	355	410	12	33	M 30 × 3
40 K	20	140	27	1	70	100	4	23	M 20
	25	150	30	2	80	110	4	23	M 20
	32	175	32	2	90	130	4	25	M 22
	40	185	34	2	105	145	8	23	M 20
	50	220	38	2	130	175	8	25	M 22
	65	230	40	2	140	185	8	25	M 22
	80	255	42	2	150	205	8	27	M 24
	(90)	270	44	2	165	220	8	27	M 24
	100	325	50	2	200	265	8	33	M 30 × 3
	125	365	54	2	240	305	12	33	M 30 × 3
	150	425	60	2	290	360	12	33	M 30 × 3
	200	500	68	2	355	430	12	39	M 36 × 3

NOTE Use of nominal diameters given in parentheses should be avoided as far as possible.

- d) The inlet design of valve end connections, regardless of type, shall be such that the minimum flow area of the external pipe or stub connection at the safety valve inlet is at least equal to passage area (inlet part) of the valve inlet end connection [see Figure 1 a)].

The outlet design of valve end connections, regardless of type, shall be such that the internal area of the external pipe at the safety valve outlet, except those valves with female threaded outlet connections, is at least equal to the minimum flow area of the valve outlet [see Figure 1 b)].



- 1 safety valve
2 valve inlet pipe
3 valve outlet pipe
 D_i required internal diameter of the safety valve for the valve to function properly

If the nominal diameter of the pipe is not equal to the nominal diameter of the valve outlet, as shown in b), then a suitable pipe shall be fitted during testing as specified in 8.1.4.

Figure 1 Design of end connections

- e) For full bore safety valves for steam service with a set pressure of 2.0 MPa (gauge) or less, the end connection may be given external threads. In this case, the connection screw shall be as given in Table 2.

Table 2 Nominal thread sizes for full bore safety valves for steam service, corresponding to their nominal sizes

Nominal size of safety valves (A)	Nominal size of taper pipe thread (see JIS B 0203)
20	R1
25	R1 ¹ / ₄
32	R1 ¹ / ₂
40	R2
50	R2 ¹ / ₂

5.3 Spring

The requirements for springs are given in Table D.

5.4 Dimension of each part of safety valve

The dimensional tolerances on each part of the safety valve shall be as follows.

- a) The dimensional tolerances for parts of the safety valve to which no specification is given and for the as-cast products shall be in accordance with Table 3.

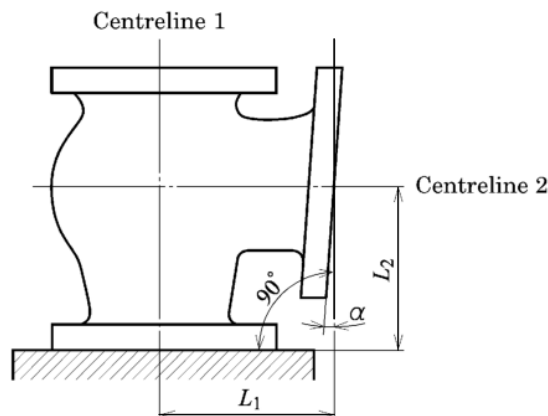
Table 3 Dimensional tolerances

Part	Dimensional tolerances	
Flange	See JIS B 2220 , JIS B 2239 or JIS B 2240	
As-cast thickness	Bronze product	+15 -10 % or ± 0.5 mm, whichever is the larger in absolute value
	Cast iron product	Tolerances for ordinary grade specified in Annex 2 of JIS B 0403
	Cast steel product	Tolerances for medium grade or ordinary grade specified in Annex 2 of JIS B 0403
Machined part	Tolerances for medium grade or coarse grade specified in JIS B 0405	

- b) Design values of valve inlet diameter, throat diameter and seat diameter are subject to plus tolerances of medium grade specified in **JIS B 0405**, with no permission of minus tolerances.
- c) The tolerances on dimensions and perpendicularity of the safety valves shown in Figure 2 shall be in accordance with Table 4.

Table 4 Tolerances on dimensions and perpendicularity

Nominal size of safety valve (A)	Tolerance on L_1 and L_2 (design value) mm	Tolerance, α , on perpendicularity min
100 or under	± 1.5	± 30
Over 100 up to and incl. 250	± 3.0	± 20
Over 250	± 3.0	± 15



L_1 : distance between centreline 1 and the outlet side flange face

L_2 : distance between centreline 2 and the inlet side flange face

Figure 2 Tolerances on dimensions and perpendicularity of safety valve

5.5 Non-destructive tests

5.5.1 General

The general requirements for non-destructive tests of safety valves are provided in the following. These non-destructive tests shall be performed only when agreed between the purchaser and the manufacturer.

5.5.2 Groove parts of inlet side butt welded joints of welding type safety valves (in the case of cast steel)

- a) The radiographic test as specified in **JIS G 0581** shall be performed, and the results shall conform to Class 1 requirements. The effective range of the radiographs of the groove part shall be 1.5 times the wall thickness of pipe or 50 mm, whichever is the smaller, from the butted end face.

Where this requirement is not applicable, that agreed between the purchaser and the manufacturer shall be applied.

- b) The groove parts, after finish, shall be subjected to the liquid penetrant test as specified in **JIS Z 2343-1**, and the results shall conform to the following items.
 - 1) Cracks shall not be found.
 - 2) In any rectangular area 38 mm × 152 mm maximum in size or any circular area 89 mm maximum in diameter at the most disadvantageous place with defects, there shall be no group of defects consisting of more than six linear discontinuities.
 - 3) There shall be no linear discontinuities of which the length is greater than 6 mm for wall thicknesses of 19 mm or under, greater than 1/3 the wall thickness for wall thicknesses over 19 mm to 57 mm, and greater than 19 mm for wall thicknesses of 57 mm or over. Those penetrant indications, as specified in **JIS Z 2343-1**, that align linearly with each other with an interval equal to or greater than the length of a longer discontinuity shall be regarded as independent indications.
 - 4) Discontinuities, other than linear, of size greater than 2.3 mm shall not be found.

5.5.3 Groove parts of inlet side butt-welded joint of welding type safety valves (in the case of forged or rolled material)

The groove parts of the inlet side butt-welded joints of welding type safety valves shall be in accordance with **5.5.2 b)**.

5.5.4 Root parts of inlet side flanges of flange type safety valves (in the case of casting)

The root parts of the inlet side flanges of chromium-molybdenum low alloy steel casting or safety valves made of cast steel of set pressure 11 MPa or over shall be subjected to the radiographic test specified in **JIS G 0581**, and the results, if the valve is 20 mm or under in wall thickness, shall conform to Class 1 and if the valve exceeds 20 mm in wall thickness, shall conform to Class 2 or better.

5.5.5 Welds for mounting valve seat

The welding groove faces when mounting the valve seat to the valve cage by welding and the welds thereof shall conform to **5.5.2 b)**.

5.5.6 Contacting surface of valve seat with valve disc

The contacting surface of valve seat with valve disc, when subjected to the liquid penetrant test specified in **JIS Z 2343-1**, shall be free from harmful defects such as cracks.

5.5.7 Butt-welded joints of inlet side pressure-retaining shells

The butt-welded joints of the inlet side pressure portions shall be subjected to the radiographic test specified in **JIS Z 3104** or **JIS Z 3106**, and the defects in their welds shall fall under Class 2 or higher. Where this requirement cannot be applied due to valve construction or other reasons, the requirement agreed between the purchaser and the manufacturer shall be applied.

5.6 Appearance

For appearance inspection of safety valves, an assembled product shall be inspected visually, and shall satisfy the following requirements.

- a) The castings shall be free from harmful blow holes, burrs, sand burning, sand inclusion, cracks, or other defects.
- b) The forgings shall be free from cracks, laps, and necking flaws or other defects.
- c) The machined surfaces shall be free from harmful flaws, irregularities in degree of finish or other defects.
- d) The edges and corners to which no specific dimension is assigned shall be chamfered, rounded or receive other appropriate treatment.

6 Materials

6.1 General

The materials of pressure-retaining shells shall satisfy requirements given in **JIS B 8201**, **JIS B 8265**, or **JIS B 8267**, depending on the application of the safety valve⁶⁾. Materials other than these may be used upon agreement between the purchaser and the manufacturer.

Note ⁶⁾ The **JIS** applicable to the machine to incorporate the safety valve concerned shall be referred to.

6.2 Restrictions on use of materials

6.2.1 Safety valves for steam service

The safety valves for steam service are subject to the following restrictions.

- a) Grey iron castings specified in **JIS G 5501**, black heart malleable iron castings and pearlite malleable iron castings specified in **JIS G 5705** shall not be used for the pressure-retaining shells of the following safety valves:
 - 1) The safety valves with a set pressure exceeding 1.6 MPa (gauge), and for black heart malleable iron casting, the safety valves with a set pressure exceeding 2.4 MPa (gauge).
 - 2) The safety valves with a fluid temperature exceeding 230 °C, and for blackheart malleable iron castings, the safety valves with a fluid temperature exceeding 350 °C.
- b) Bronze castings of Class 2, Class 3, Class 6 and Class 7 specified in **JIS H 5120** shall not be used for safety valves for steam boilers exceeding 208 °C in temperature, or for other safety valves exceeding 225 °C in temperature.
- c) For temperature limits for other materials, the **JIS** applicable to the machine to incorporate the safety valve concerned shall be normally referred to.

6.2.2 Safety valves for gas and liquid services

The safety valves for gas and liquid services are subject to the following restrictions.

- a) Grey iron castings specified in **JIS G 5501** shall not be used for pressure-retaining shells of the safety valves to be used for toxic or combustible fluid services, those of the safety valves with a set pressure of 0.2 MPa (gauge) or over, or those of the safety valves under 0 °C or over 250 °C in temperature.
- b) Spheroidal graphite iron castings specified in **JIS G 5502** and malleable iron castings specified in **JIS G 5705** shall not be used for the pressure-retaining shells of the safety valves for toxic or combustible fluids with a set pressure of 0.2 MPa (gauge) or over, those of safety valves for fluids other than toxic or combustible with a set pressure of over 1.6 MPa (gauge), or those of the safety valves with a fluid temperature under 0 °C or over 250 °C.
- c) For temperature limits for other materials, the **JIS** applicable to the machine to incorporate the safety valve concerned shall be normally referred to.

7 Production testing

7.1 Objective

The purpose of these tests specified in **7.3** to **7.8** is to ensure that all safety valves meet the requirements ⁷⁾ for which they have been designed and can be operated at a specified pressure without exhibiting any form of leakage from pressure-retaining components or joints.

Note ⁷⁾ The operating characteristics are tested in accordance with **8.2**, or alternatively in accordance with **7.8**. In either case, the set pressure needs to be adjusted according to **7.5**.

The flow characteristics, not included in the requirements referred to in this subclause, are tested in accordance with **8.3**, or alternatively in accordance with Annex JA.

7.2 General

It is permissible to adopt an alternative test of equal validity (e.g. proof of design tests associated with statistical sampling) to the hydrostatic test for valve shells with:

- a) threaded ends; and
- b) a maximum inlet diameter of 32 mm; and
- c) a ratio of bursting pressure to set pressure of at least 8; and
- d) set pressure equal to or less than 4 MPa (gauge); and
- e) for use with non-hazardous fluids;
and also for valves as above but with:
- f) a set pressure greater than 4 MPa (gauge); and
- g) a ratio of bursting pressure to design pressure of at least 10; and
- h) material which is either wrought or forged.

All temporary pipes and connections and blanking devices shall be adequate to safely withstand the test pressure.

Any temporary welded-on attachments shall be carefully removed and the resulting weld scars shall be ground flush with the parent material. After grinding, all such scars shall be inspected by using magnetic particle or fluid penetrant techniques.

7.3 Hydrostatic testing

7.3.1 Application

- a) The portion of the valve from the inlet to the seat shall be tested to a pressure 1.5 times the manufacturer's stated maximum pressure for which the safety valve is designed.
- b) The portion of the valve from the seat surface to the discharge side shall be tested to 1.5 times the manufacturer's stated maximum back pressure for which the valve is designed. This pressure can be lower than that given by the outlet flange rating; where it is 0 or not specified, no testing is required.
- c) In addition to a) and b), a **JIS** applicable to the machine incorporating the safety valve concerned may also be referred to.

7.3.2 Duration

The test pressure, selected suitably for the nominal size of the valve, shall be applied and maintained at the required magnitude for a sufficient length of time to permit a visual examination to be made of all surfaces and joints, but in any case for not less than the times given in Table 5.

For tests on the discharge side of the seat, the testing time shall be based on the nominal size of the valve on the discharge side.

Table 5 Minimum duration of hydrostatic test

Nominal size (A)	Minimum duration (s)
50 or under	15
Over 50 up to and incl. 200	60
Over 200 up to and incl. 600	180
Over 600	<u>As agreed between the purchaser and the manufacturer</u>

7.3.3 Acceptance criteria

No leakage from the tested parts as defined in **7.3.1** is accepted.

7.3.4 Safety requirements

Requirements for safety during hydraulic pressure test are given in following **a)** to **d)**.

- a) Water appropriately controlled shall normally be used as the test medium. Where other liquids are used, additional precautions may be necessary.
- b) Valve bodies shall be properly vented to remove entrapped air.
- c) If materials which are liable to failure by brittle fracture are incorporated in that part of the safety valve which is to be hydrostatically tested, then both the safety valve, or part thereof, and the testing medium shall be at a sufficient temperature which is at least equal to the ductility-brittleness transition temperature of the material to prevent the possibility of such failure.
- d) No valve or part thereof undergoing pressure testing shall be subjected to any form of shock loading, for example hammer testing.

7.4 Pneumatic testing

7.4.1 Application and duration of test

Pneumatic testing with air or other suitable gas may be carried out in place of the standard shell hydraulic test specified in **7.3** upon the agreement between the purchaser and the manufacturer in the following cases **a)** and **b)**.

- a) Safety valves of such design and construction that it is not practicable for them to be filled with liquid.
- b) Safety valves that are to be used in service where even small traces of water cannot be tolerated.

The portions of the valve to be tested, test pressure and duration of application shall be as specified in **7.3**.

7.4.2 Acceptance criteria

No leakage from the tested parts as defined in **7.3.1** is accepted.

7.4.3 Safety requirements

For the hazards involved in pneumatic pressure testing, adequate precautions shall be taken according to following a) to c).

- a) If a major rupture of the valve should occur at some stage during application of pressure, considerable energy will be released; hence no personnel should be in the immediate vicinity during pressure raising (for example a given volume of air contains a far greater amount of energy than a similar volume of water contains, when both are at the same pressure).
- b) The risk of brittle failure under test conditions shall have been critically assessed at the design stage and the choice of materials for valves that are to be pneumatically tested shall be such as to avoid the risk of brittle failure during test. This necessitates provision of an adequate margin between the ductility-brittleness transition temperature of all parts and the metal temperature during testing.
- c) Attention is drawn to the fact that if there is a reduction in gas pressure between the high pressure storage and the valve under test, the gas temperature will decrease.

Valves undergoing pneumatic test should not be approached for close inspection until after the pressure increase has been completed. No valve undergoing pneumatic test shall be subject to any form of shock loading. Precautions shall be taken against pressures generated in excess of test pressure.

7.5 Adjustment of set or cold differential test pressure

Each safety valve shall be adjusted to its designated set or cold differential test pressure. Before adjusting a safety valve to the set or, if applicable, cold differential test pressure using air or other gas as the test medium, it shall previously be subjected to a hydrostatic test (see 7.3).

7.6 Seat leakage test

7.6.1 General

The seat leakage test of a safety valve shall be carried out after adjustment of the set or cold differential test pressure, applying 7.6.2, 7.6.3, 7.6.4, or 7.6.5 depending on the kind of medium agreed between the manufacturer and the purchaser.

To ensure safety, the following tests shall be conducted by operators familiar with and experienced in the use and operation of safety valves.

NOTE Leakage inspection should be made via mirror or other similar means so that in cases where the valve suddenly pops, the inspector's face is not directly in the valve discharging trajectory.

7.6.2 Test using air

- a) **Apparatus**, as shown in Figure 3.
- b) **Procedure**
 - 1) Use air (or nitrogen) at ambient temperature as the test medium.

- 2) Set the safety valve upright on the test bench, and connect the testing instrument to the valve discharge side as shown in Figure 3. The pipe shall be cut normal to its axis so as to have ends with smooth sections. Immerse the pipe in water so that the pipe axis is normal to the water surface. Close all openings including the drain pipes and vent holes, as well as the cover.
 - 3) For safety valves with a set pressure over 300 kPa (gauge), set the valve inlet pressure at 90 % of the set pressure, and determine the number of air bubbles per minute. For those with a set pressure 300 kPa or under, set the test pressure at 30 kPa lower than the set pressure.
 - 4) Prior to testing, define the set pressure, and remove moisture inside the valve. Check by appropriate means that all joints and fitting components of the valve are firmly connected. Before counting the air bubbles, keep the valve under pressure for the duration specified in Table 6, and then examine for leakage for 1 min or longer in the case of metal seat type and for 1 min in the case of soft seat type.
- c) **Acceptance criteria** For metal seat type, the number of bubbles counted during 1 min shall not exceed the value given in Table 7. For soft seat type, there shall be no leakage (air bubble count 0/min) during 1 min after keeping under pressure.

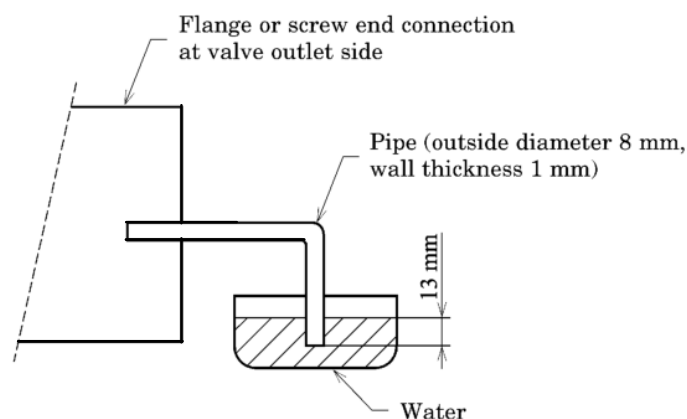


Figure 3 Seat leakage test instrument using air†

Table 6 Duration of pressure application before counting air bubbles

Nominal size of safety valve (A)	Duration of pressure application (min)
50 or under	1 min.
65, 80 and 100	2 min.
125 or over	5 min.

Table 7 Maximum allowable leakage for metal seat type

Set pressure of safety valve kPa (gauge)	Flow diameter 18 mm or under	Flow diameter over 18 mm
	Air bubble count/min	Air bubble count/min
Over 100 up to and incl. 6 896	40	20
Over 6 896 up to and incl. 10 300	60	30
Over 10 300 up to and incl. 13 800	80	40
Over 13 800 up to and incl. 17 200	100	50
Over 17 200 up to and incl. 20 700	100	60
Over 20 700 up to and incl. 27 600	100	80
Over 27 600 up to and incl. 34 400	100	100
Over 34 400 up to and incl. 41 400	100	100
Over 41 400	100	100

7.6.3 Test using steam**a) Procedure**

- 1) Use steam as the test medium.
- 2) Set the safety valve upright on the test bench.
- 3) For safety valves with a set pressure over 300 kPa (gauge), set the valve inlet pressure at 90 % of the set pressure, and for valves with a set pressure 300 kPa or under, set the test pressure at 30 kPa lower than the set pressure.
- 4) Prior to testing, define the set pressure, and remove moisture inside the valve using air (or nitrogen) as appropriate. Then determine the set pressure, and increase the valve inlet pressure up to the test pressure. Keep under the test pressure at least for 3 min. Examine for leakage for 1 min by acoustic or visual checking.

- b) **Acceptance criteria** For both metal seat type and soft seat type, there shall be no audible or visible leakage during 1 min after keeping under pressure.

7.6.4 Test using water**a) Procedure**

- 1) Use water at ambient temperature as the test medium.
- 2) Set the safety valve upright on the test bench for water testing.
- 3) For safety valves with a set pressure over 300 kPa (gauge), set the valve inlet pressure at 90 % of the set pressure, and for valves with a set pressure 300 kPa or under, set the test pressure at 30 kPa lower than the set pressure.
- 4) Prior to testing, define the set pressure, and where no visible flow is observed from the valve outlet, ensure that the water surface in the discharge side is stable. Increase the valve inlet pressure up to the test pressure, keep under this pressure for 1 min, and examine for leakage. Collect the discharge of water from the valve discharge side, and measure its amount.

- b) **Acceptance criteria** There shall be no leakage exceeding the amount specified in Table 8.

Table 8 Allowable leakage

Metal seat type (converted leakage per min)		Soft seat type (leakage per min)
Nominal size 25 (A) or over	$\{6.67 \times 10^{-3} \times [\text{value of nominal size (A)}]\} \text{ cm}^3 \text{ max.}$	0
Nominal size under 25 (A)	$1.67 \times 10^{-1} \text{ cm}^3 \text{ max.}$	

7.6.5 Test using air—Alternative method

- a) **Applicable valve types** Safety valves of open bonnet type⁸⁾ may be tested by the following method instead of the method specified in 7.6.2, unless their design is such that the air bubbles travel through the inner passage of the valve guide to the open bonnet, and thus cannot be observed at the valve outlet.

Note ⁸⁾ Valves with a bonnet that cannot be completely closed, in contrast to the type of valve shown in 7.6.2 b) 2).

b) **Procedure**

- 1) Use air (or nitrogen) at ambient temperature as the test medium.
 - 2) Set the safety valve upright on the test bench for air testing, filling the valve outlet with water up to 13 mm above the seating surface of the valve seat.
 - 3) For safety valves with a set pressure over 300 kPa (gauge), set the valve inlet pressure at 90 % of the set pressure, and for valves with a set pressure 300 kPa or under, set the test pressure at 30 kPa lower than the set pressure. Count the number of air bubbles per min.
 - 4) Prior to testing, define the set pressure, and fill the liquid receiver at the discharge side with water up to the level specified above. Increase the valve inlet pressure up to the test pressure, and keep under this pressure for 1 min before counting air bubbles. Then examine for leakage for 1 min or longer in the case of metal seat type and for 1 min in the case of soft seat type.
- c) **Acceptance criteria** For metal seat type, the number of bubbles counted during 1 min shall not exceed 50 % of the value given in Table 7. For soft seat type, there shall be no leakage (air bubble count 0/min) during 1 min after keeping under pressure.

7.7 Sealing performance test

7.7.1 Inlet side

The sealing performance of the inlet side of the safety valve shall be visually checked, and evaluated together with 7.3.1 a).

7.7.2 Discharge side

The sealing performance of the discharge side of the safety valve shall be checked visually and evaluated as follows.

- a) **Safety valves with a specified back pressure** Perform evaluation of the sealing performance of the discharge side at the same time as the evaluation specified in 7.3.1 b).
- b) **Closed-type safety valves with no specified back pressure** Evaluate the sealing performance of the discharge side by applying an air or other gas pressure of 0.2 MPa to the portion of the discharge side which is subjected to the back pressure.

The test duration shall be in accordance with 7.3.2.

NOTE For the definition of “closed type safety valve”, see JIS B 0100.

7.7.3 Acceptance criteria

No leakage from the tested parts as defined in 7.3.1 is accepted.

7.8 Operating performance test

7.8.1 General

The operating performance test performed as a product test shall be in accordance with 7.8.2 to 7.8.5. Where the testing laboratory is not capable of realizing the specified test conditions, other test method and medium than specified may be used upon agreement between the purchaser and the manufacturer.

7.8.2 Start-to-discharge pressure

Increase the inlet side pressure of the safety valve until a trace amount of discharge of fluid is detected at the discharge side, and measure the inlet side pressure at this time (start-to-discharge pressure). The start-to-discharge pressure shall be as follows.

- a) **Safety valves for steam service** The start-to-discharge pressure is not specified.
- b) **Safety valves for gas and liquid services** The tolerance on the start-to-discharge pressure shall be $\pm 5 \%$ (minimum ± 0.025 MPa) of the set pressure. In the case where the set pressure should not be exceeded, the plus tolerance shall be added to the minus tolerance.

The set pressure is normally determined corresponding to the start-to-discharge pressure.

7.8.3 Opening pressure (popping pressure)

Increase the inlet side pressure of the safety valve until the valve pops, and measure the inlet side pressure at this time (opening pressure). The opening pressure shall be as follows.

- a) **Safety valves for steam service** The tolerance on the opening pressure shall be in accordance with Table 9. For safety valves for other purposes than boilers, the tolerance may be $\pm 3 \%$ (minimum ± 0.015 MPa) of the set pressure. In the case where the set pressure should not be exceeded, the plus tolerance shall be added to the minus tolerance.