

JIS

JAPANESE INDUSTRIAL STANDARD

**Electrical Apparatus for Use
in Gassy Coal Mines**

JIS C 0901—1983

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In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

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J I S

Electrical Apparatus for Use in Gassy Coal Mines

C 0901-1983

1. Scope

This Japanese Industrial Standard specifies the requirements for the explosion-proof construction of electrical machinery and apparatus, hereinafter referred to as the "electric apparatus", to be used either individually or as part of other equipment at the coal mine liable to contain combustible gas mainly consisting of methane or explosive coal dust.

Further, the intrinsically safe explosion-proof construction also applies to the construction of the intrinsically safe apparatus and intrinsically safe related apparatus to be installed at non-hazardous locations.

- Remarks 1. When an explosion-proof capacity can be guaranteed against the mine gas, it can also be guaranteed against the coal dust.
2. The units and numerical values shown in { } in this Standard are in accordance with the International System of Units (SI) and are appended for reference.

2. Definition

For the purposes of this standard, the following definition shall apply.

- (1) enclosure An explosion-proof casing such as the outer case of a rotary machine, the outer box of a transformer and a switch and the like.
- (2) locking To lock so that the locked part cannot be loosened, unless a special tool is used.
- (3) gap and depth of gap
 - (a) A gap means the maximum clearance between mating parts or sealed parts facing the enclosure or the maximum difference in diameter between a hole and a shaft or a rod under the normal condition where no pressure is applied inside the enclosure of flame-proof enclosure explosion-proof construction.
 - (b) Depth of a gap means the minimum length of a gap across the portion in the enclosure of flame-proof enclosure explosion-proof construction when the gap is kept under the permissible value.
- (4) creepage distance for insulation The shortest distance liable to cause electric leakage along the surface of the insulating material between a bare live part and other part to be insulated therefrom.
- (5) insulation air distance The shortest air distance between a bare live part and other part to be insulated therefrom.
- (6) mine gas Mixed gas of combustible gas mainly consisting of methane and air.

Applicable Standards, Corresponding International Standard and Reference Standards: See page 37,

- (7) hazardous location A location where the mine gas creates a hazardous atmosphere and an explosion or a combustion is liable to take place.
- (8) non-hazardous location A location other than a hazardous location.
- (9) hazardous atmosphere An atmosphere in the state where the density of the mine gas is within the limit of an explosion.
- (10) ignition source An electric spark or arc or a high temperature part having energy enough to cause an explosion of a hazardous atmosphere.
- (11) transparent window A window provided with a transparent plate to see the inside of an enclosure and constituting part of the enclosure.
- (12) flame escape To ignite the ambient mine gas, when a flame caused by an explosion inside an enclosure of the flame-proof enclosure explosion-proof construction passes through the joint surfaces of the enclosure.
- (13) protective gas Clean air or inert gas used to maintain the pressure in inside of the enclosure with pressurized-enclosure explosion-proof construction to the predetermined value.
- (14) sweeping gas To expel the mine gas which has penetrated during power-off by sending protective gas in an enclosure and ventilation pipes before energizing in connection with the pressurized-enclosure explosion-proof construction.
- (15) terms used for intrinsically safe explosion-proof construction
 - (a) intrinsically safe circuit An electric circuit which has been confirmed by the testing conditions and methods specified in 4.6 of JIS C 0902 that its electric sparks or arcs and high temperature part do not ignite the mine gas.
 - (b) non-intrinsically safe circuit An electric circuit other than the intrinsically safe circuit.
 - (c) intrinsically safe apparatus An electric apparatus whose all electric circuits consist of intrinsically safe circuits.
 - (d) intrinsically safe related apparatus An electric apparatus designed to comply with the requirements of the specifications necessary to maintain the intrinsically safe explosion-proof property of an intrinsically safe circuit to which it is directly or indirectly connected.
 - (e) intrinsically safe independent installation An installation solely consisting of 2 or more intrinsically safe apparatus.
 - (f) intrinsically safe combined installation An installation with an intrinsically safe apparatus and an intrinsically safe related apparatus combined or intrinsically safe related apparatus alone combined.

- (g) safety maintenance element A part used for maintaining the intrinsically safe explosion-proof property of an electric circuit and designed to comply with the requirements of the predetermined specifications.
- (h) safety maintenance circuit An electric circuit including safety maintenance elements with a function to restrict a voltage or a current or both.
- (i) safety maintenance rating A rating specified for a intrinsically safe apparatus and an intrinsically safe related apparatus and the maximum rating capable of maintaining the intrinsically safe explosion-proof property of the intrinsically safe circuit concerned.
- (j) safety maintenance device An intrinsically safe related apparatus which mainly consists of safety maintenance elements and safety maintenance circuits and restricts the inflow of electric energy liable to cause ignition to the intrinsically safe circuits concerned from non-intrinsically safe circuits within the range of the safety maintenance rating.
- (k) separation distance The shortest distance between live parts completely filled with an insulating material such as synthetic resin.

3. Classes of Explosion-Proof Construction

3.1 Flame-Proof Enclosure Explosion-Proof Construction A construction that is totally enclosed and is capable of withstanding the pressure caused by an explosion of the mine gas which takes place within the enclosure and does not give rise to the possibility of igniting the mine gas outside the enclosure.

3.2 Narrow-Gap Explosion-Proof Construction A construction that the inside of enclosure is communicated with the outside by narrow gaps and when an explosion of mine gas in the enclosure is caused, the dangerous rise of pressure is prevented by blowing out the gas through the narrow gaps from the inside and at the same time, has no possibility of igniting the outside mine gas.

3.3 Oil-Immersed Explosion-Proof Construction A construction that the parts of electric apparatus which may cause sparks or arcs are immersed in oil so as to eliminate the possibility of igniting mine gas existing above the oil level.

3.4 Pressurized-Enclosure Explosion-Proof Construction A construction that the penetration of mine gas is prevented by maintaining the pressure with protective gas (clean air or inert gas) which is filled up within the enclosure.

The pressurized construction is further classified into following 3 classes of ventilated type pressurized construction, enclosed type pressurized construction and sealed type pressurized construction according to the systems of maintaining the inside pressure.

- (1) Ventilated Type Pressurized Construction A system where the enclosure has an inlet and outlet for ventilation, and the pressure difference between the inside and outside of the enclosure caused by forced ventilation prevents the mine gas from entering inside the enclosure.
- (2) Enclosed Type Pressurized Construction A system where the enclosure itself of an apparatus is totally enclosed, and in case of slight gas leakage, the internal pressure necessary for the maintenance of pressurized construction is obtained by the continuous or occasional pressing-in of the protective gas into the enclosure. No exhaust outlet is used in normal operation.
- (3) Sealed Type Pressurized Construction A system to maintain the internal pressure by sealing completely the protective gas and eliminating the risk of leakage.

3.5 Increased Safety Explosion-Proof Construction A construction that safety is particularly increased in the construction or on temperature rise so as to prevent sparks, arcs or overheat from occurring in those parts which should not produce them during normal operation.

3.6 Intrinsically Safe Explosion-Proof Construction A construction confirmed by ignition tests or others that sparks, arcs or overheat produced during normal operation or in accidents do not ignite the mine gas.

3.7 Special Explosion-Proof Construction A construction other than the above methods 3.1 to 3.6, for which prevention of ignition of the mine gas has been confirmed by tests or others.

4. Symbols for Explosion-Proof Construction

The symbols for the explosion-proof construction shall be as follows:

- (1) The symbols for the explosion-proof construction are specified as indicated in Table 1.

Table 1. Symbols for Explosion-Proof Construction (1)

Class of explosion-proof construction	Symbol
Flame-proof enclosure construction	fla.
Narrow gap construction	nar.
Oil-immersed construction	oil
Pressurized-enclosure construction	pre.
Increased safety construction	inc.
Intrinsically safe construction	int.
Special construction	spe.

- (2) In the case of an intrinsically safe related apparatus which has both an intrinsically safe circuit assembly and a non-intrinsically safe circuit assembly, its symbol is as indicated in Table 2, combining both symbols.

Table 2. Symbols for Explosion-Proof Construction (2)

Explosion-proof construction of intrinsically safe circuit assembly	Explosion-proof construction of non-intrinsically safe circuit assembly	Symbol
Intrinsically safe explosion-proof construction	Flame-proof enclosure construction	i. fla.
	Narrow gap construction	i. nar.
	Pressurized enclosure construction	i. pre.
	Increased safety construction	i. inc.
	Special construction	i. spe.
	Construction other than explosion-proof construction	o. t.

- (3) In the case of an intrinsically safe combined installation consisting of 2 or more apparatus of an intrinsically safe apparatus and an intrinsically safe related apparatus, its symbol shall be, for example, (i), (i. fla.) or (o.t.), indicating its combination. In such case, however, each apparatus constituting the combined installation shall be marked with the same symbol, and furthermore, each apparatus shall have its own explosion-proof symbol underlined or marked appropriately.

5. Explosion-Proof Construction in General

5.1 General Rules of Explosion-Proof Construction The general rules of the explosion-proof construction shall be as follows:

- (1) The explosion-proof construction of an electric apparatus shall conform to this standard. However, even when detailed parts of the explosion-proof construction have types of construction and materials other than those specified in this standard, they are acceptable, provided that they are confirmed by tests or others conducted by a public organization that they have a sufficient explosion-proof capacity.

- (2) An electric apparatus of the explosion-proof construction shall be of construction which is sturdy and easy for maintenance, taking into consideration the environmental conditions in coal mines (such as the effects of impacts, changes in temperature, moisture, dust and pollution), and materials used shall have adequate electrical, mechanical, thermal and chemical resistances.

Furthermore, when there is the risk of condensation and accumulation of water in an apparatus and others, measures for the prevention of condensation and accumulation of water or methods for expelling accumulated water shall be taken.

Remark: Those used at coal faces or near coal faces, in particular, have the least risk of spark generation due to abrasion of metals.

5.2 Ambient Temperature and Limit of Temperature Rise Ambient temperature and the limit of a temperature rise shall be as follows:

- (1) The limit of the reference ambient temperature for an electric apparatus in service condition shall be 40°C, unless otherwise specified, and the limit of a temperature rise for an electric apparatus shall be determined on this basis.
- (2) The limit of a temperature rise for parts of an electric apparatus liable to come in contact with the mine gas shall be 160°C.
- (3) When the limit of the reference ambient temperature exceeds 40°C, the limit of a temperature rise for an electric apparatus shall be lowered by the amount exceeding that value. In this case, the electric apparatus shall be marked with its reference ambient temperature.
- (4) When cooling water is used for a refrigerant, necessary items such as the temperature of the refrigerant, its flow quantity and others which are the conditions of deciding the limit of a temperature rise shall be indicated.
- (5) When a temperature rise is affected by heat conduction and heat radiation of machines and appliances, the conditions of use shall be clarified, and the limit of a temperature rise shall be determined. The conditions of use shall be indicated in this case.
- (6) When a temperature rise is affected by use, rating and a method of operation, these conditions shall be clarified and necessary items shall be indicated.

5.3 Application of Explosion-Proof Construction for Electric Apparatus

The application of the explosion-proof construction for an electric apparatus shall conform to the following:

- (1) In an electric apparatus those parts which may cause in normal operation sparks, arcs or high temperature which may become a source of ignition shall conform to one of the following types of explosion-proof construction:

- (a) Flame-proof enclosure construction
- (b) Narrow gap construction
- (c) Oil-immersed construction
- (d) Pressurized-enclosure construction
- (e) Special explosion-proof construction

Furthermore, the explosion-proof construction of electric apparatus for power⁽¹⁾ (rotary machines, transformers, switches, fuses, plug-in connectors, resistors and rectifiers) shall conform to Appendix 1.

Note ⁽¹⁾ Measuring instruments and illumination appliances are not included.

- (2) Electric apparatus which are not liable to cause in normal operation sparks, arcs or high temperature which may become a source of ignition may be of the increased safety explosion-proof construction other than the explosion-proof construction in (1).
- (3) Parts of electric apparatus which are considered not to be liable to cause in normal operation or in accidents sparks, arcs or high temperature which may become a source of ignition may be of the intrinsically safe explosion-proof construction upon confirmation by tests and others.

5.4 Markings of Explosion-Proof Construction An electric apparatus of the explosion-proof construction shall be marked to be the explosion-proof construction and the like in its visible location of the main body in addition to the mark required basing on each standard, in particular, in accordance with the following:

- (1) To mark the symbol for the class of the explosion-proof construction.
- (2) An electric apparatus with 2 or more classes of explosion-proof construction combined shall be marked as indicated below; however, in the case of "i. inc." combination of the intrinsically safe explosion-proof construction, it shall be marked in compliance with 4. (2) and (3).
 - (a) The symbol of its apparatus proper shall be indicated.
 - (b) Each part constituting the apparatus shall also be marked with the symbol of each explosion-proof construction, when it is necessary for its handling and securing its safety property.
- (3) An electric apparatus of the explosion-proof construction, when it is necessary to indicate its conditions of use, shall be clearly marked with their gist.

5.5 Construction of Locking

5.5.1 Application of Locking Screws and the like used on an electric apparatus which may cause hazards when loosened from outside shall be locked in accordance with the following:

- (1) Screws and the like which are required to maintain an explosion-proof capacity and can be loosened from outside shall be locked. However, those which need not be loosened except at the time of dismounting or assembling and which are not liable to be loosened by those other than authorized persons and give little effects to an explosion-proof capacity are permitted to omit locking.

Likewise when locking of construction is achieved sure by the by the way to give locking to the port of screws and the like, the locking to be given to other part of screws and the like may be omitted.

- (2) Screws and the like clamping a lid or cover of parts which are liable to cause hazards by making live parts inside accessible, when they are opened, shall be locked at least at one or two locations so that the lid or cover may not be easily opened. However, those which need not be loosened except at the time of dismounting or assembling and which are not liable to be loosened by those other than authorized persons are permitted to omit locking.

5.5.2 Construction of Locking The construction of locking shall be such as the one provided with a clamping device which cannot be easily loosened with ordinary tools such as a screw driver, spanner, plier, etc.

The dimensions for construction for hexagon head bolts, socket head bolts and machine screws most generally used are given in Appendix 2.

5.6 Connection of External Conductors to Electric Apparatus

5.6.1 Methods of Connection of External Conductors to Electric Apparatus The connection of external conductors to an electric apparatus shall be as follows:

- (1) The connection of external conductors to an electric apparatus shall, as a rule, be made through a terminal box attached to an electric apparatus. However, the connection may be made directly without using the terminal box in one of the following cases:
 - (a) When there is no other way possible due to its construction or its usage.
 - (b) When the explosion-proof construction of an electric apparatus is the pressurized-enclosure explosion-proof construction.
 - (c) When an external conductor is an intrinsically safe circuit or when an external conductor of a non-intrinsically safe circuit is connected to an intrinsically safe related apparatus at a non-hazardous location.
- (2) The connection of an external conductor to an electric apparatus in (1) (a) shall be made in accordance with Appendix 6.
- (3) The connection of an external conductor to an electric apparatus in (1) (b) shall be made in accordance with 5.6.5.

- (4) The connection of an external conductor to an electric apparatus in (1) (c) shall be made in accordance with 5.6.6.

5.6.2 Terminal Box A terminal box shall conform to the following:

- (1) A terminal box shall be attached to an electric apparatus and used to connect external conductors.
- (2) The live parts of a terminal box shall comply with the requirements of 10. and increase safety in the creepage distance, insulation air distance, construction of connecting parts, temperature rise, etc.
- (3) A terminal box shall have a sufficient width for connecting conductors.
- (4) The application of the explosion-proof construction to a terminal box shall conform to the following:
 - (a) A terminal box of an electric apparatus of the flame-proof enclosure explosion-proof construction, narrow gap explosion-proof construction and pressurized-enclosure explosion-proof construction shall, as a rule, be of the flame-proof enclosure explosion-proof construction.
 - (b) A terminal box of an electric apparatus of the oil-immersed explosion-proof construction and increased safety explosion-proof construction shall be of the increased safety explosion-proof construction.
- (5) The construction of a terminal box is given in Appendix 3.

5.6.3 Lead-in Assembly of Conductors from Terminal Box to Electric Apparatus Proper The lead-in assembly of conductors from a terminal box to an electric apparatus proper shall conform to the following:

- (1) The lead-in system of the lead-in assembly of conductors, when an electric apparatus proper is of the flame-proof enclosure explosion-proof construction or the narrow gap explosion-proof construction or a terminal box is of the flame-proof enclosure explosion-proof construction, shall be of the pressure-proof stud type, the pressure-proof packing type (the pressure-proof single-hole packing type or the pressure-proof multi-aperture packing type) or the pressure-proof fixed type (including the pressure-proof resin fixed type). However, the lead-in system of the pressure-proof multi-aperture packing type and the pressure-proof fixed type shall be applied only to low voltage circuits.

- (2) The lead-in system of the lead-in assembly of conductors, when an electric apparatus proper is of construction other than the flame-proof enclosure explosion-proof construction or the narrow gap explosion-proof construction and a terminal box is of the increased safety explosion-proof construction, shall be of the stud type, packing type (single-hole packing type or multi-aperture packing type), fixed type, bushing type or clamping type. However, the lead-in system of the multi-aperture packing type and the fixed type shall be applied only to low voltage circuits.
- (3) The construction of the lead-in system of conductors in (1) and (2) is given in Appendix 4.

5.6.4 Leading-in Assembly of External Conductors to Terminal Box

The lead-in assembly of external conductors to a terminal box shall conform to the following:

- (1) The lead-in assembly of external conductors to a terminal box of the flame-proof enclosure explosion-proof construction shall be of the pressure-proof packing type (limited to the single-hole type), pressure-proof fixed type or plug-in type.
- (2) The lead-in assembly of external conductors to a terminal box of the increased safety explosion-proof construction shall be of the packing type (limited to the single-hole type) or fixed type.
- (3) The construction of the lead-in assembly in (1) and (2) is given in Appendix 5.

5.6.5 Direct Leading-in of External Conductors to Electric Apparatus of Pressurized-Enclosure Explosion-Proof Construction Direct leading-in of conductors to an electric apparatus of the pressurized enclosure explosion-proof construction shall conform to the following:

- (1) Leading-in of external conductors to an electric apparatus proper shall be made in compliance with 5.6.4 (2).
- (2) The connecting terminal part of external conductors to an electric apparatus proper shall increase safety in the insulation air distance, creepage distance, construction of the connecting part, temperature rise, and others in accordance with the requirements of 10.
- (3) The construction of (1) shall conform to Appendix 6.

5.6.6 Direct Connection of External Conductors to Electric Apparatus of Intrinsically Safe Explosion-Proof Construction Direct connection of external conductors of an intrinsically safe circuit to an electric apparatus and direct connection of external conductors of a non-intrinsically safe circuit to an intrinsically safe related apparatus at a non-hazardous location shall conform to the following:

- (1) Connection of external conductors to an electric apparatus shall be made at a terminal stand or connector attached to the electric apparatus. The construction of the connecting part in this case is indicated in 11.2.1.

- (2) When there is a risk of the connecting part being loosened or disconnected by an excessive outer force or the self-weight of a conductor applied to the external conductor connecting part, external conductors shall be firmly secured with a clamp or other means.

5.6.7 Leading-in of Conductors within Electric Apparatus When the inside of an electric apparatus is divided into 2 or more enclosures and conductors are lead-in through its separating walls, 5.6.3 shall be applicable corresponding to the explosion-proof construction of each enclosure.

Furthermore, when 2 or more electric apparatus are assembled and composed as a set of electric apparatus, even if part of conductors connecting these is exposed outside, the lead-in system of the pressure-proof packing type, packing type or fixed type shall be used in accordance with their explosion-proof construction, and a terminal box is permitted to be omitted, if the conductors are short enough and protected against an external injury so that they are considered as inner wiring of the apparatus.

5.6.8 Earth Terminal The metallic enclosure of an electric apparatus shall be provided with an earth terminal for earthing inside and outside its terminal box in accordance with (1) and (2) mentioned below; however, a transferable apparatus shall not be provided with an external earth terminal. The external earth terminal shall be a separate part from mounting screws or mounting base bolts and shall not be used as such at the same time.

- (1) When there is a terminal box, the following shall be conformed to:
- (a) An external earth terminal may be mounted on a part other than a terminal box and shall be so constructed as to connect securely an earth wire.
 - (b) An earth terminal shall be provided with a retainer to prevent loosening.
 - (c) An earth terminal shall not be mounted penetrating through an enclosure of the flame-proof enclosure explosion-proof construction. This provision, however, is not applicable to a as to retain the explosion-proof property; for example, when a stud is firmly inserted.
 - (d) An earth terminal shall be indicated with a letter mark E or a drawing symbol.
- (2) In the case of direct leading-in, the following shall be conformed to:
- (a) An earth terminal shall be provided inside and outside an electric apparatus.
 - (b) A retainer to prevent loosening shall be mounted and a marking be made in accordance with (1) (a) and (b).

6. Flame-Proof Enclosure Explosion-Proof Construction6.1 Enclosure

6.1.1 Strength of Enclosure The strength of enclosure shall be as follows:

- (1) The enclosure shall be capable of withstanding internal pressure shown in Table 3 according to its internal volume. For enclosures 2 cm³ or under it is sufficient, if they have the strength required for manufacture and service.

Table 3. Internal Pressure (Gauge Pressure)

Unit: kgf/cm ² {kpa}		
Internal volume	Over 2 cm ³ to 100 cm ³ incl.	Over 100 cm ³
Internal pressure	6 {588.4}	8 {785}

- (2) Internal volume which is required to determine the strength of the enclosure shall be the internal volume of the enclosure itself subtracted by the volume of the contents of the enclosure indispensable for the operation of an apparatus.
- (3) The construction where an enclosure is divided into 2 or more compartments and they are communicated mutually with a small hole shall be avoided as far as possible. Even when there is no other way than using such construction, if the value 1.5 times the actually measured pressure by the explosion test of the enclosure exceeds that of Table 3, the strength of the enclosure shall be designed to withstand the higher pressure.

6.1.2 Contents in Enclosure The opening and closing contacts and winding in an enclosure shall not be immersed in oil.

6.1.3 Transparent Window The opening of a transparent window shall be the minimum dimensions required. The opening 50 cm² or more may be used only in unavoidable cases. In this case, however, a transparent plate used for the transparent window shall require a special protection (e.g., a grille, protective panel, and others) against mechanical damage.

The transparent window shall be so constructed as to be replaceable.

The transparent plate used for the transparent window shall conform to the following:

- (1) The transparent plate shall be of laminated glass specified in JIS R 3205, tempered glass specified in JIS R 3206 or a non-combustible material equivalent to or superior to these in strength, and it shall be capable of withstanding a temperature rise on one side securely at the time of an explosion.

- (2) The transparent plate shall have strength to withstand without damage an impact of a steel ball with a mass of 200 g falling from the height of 200 cm in the state that it is mounted on the transparent window.
- (3) The transparent plate shall be so mounted as to receive no dangerous stress.

6.2 Depth of Gap and Gap

6.2.1 Joint Surfaces The depth of the gap and the gap between joint surfaces shall be as follows:

- (1) The depth of the gap shall be as long as possible, and the gap shall be as small as possible, and they shall be so designed that they will not be enlarged by effects caused in operation.
- (2) The depth of the gap and the gap between joint surfaces which do not move relatively in operation (e.g., the flange portion and mating portion) or between joint surfaces which move only occasionally (e.g., the penetrating part of an operating rod) shall conform to Table 4 in accordance with the internal volume of an enclosure. When required due to construction, however, the value corresponding to a larger compartment of the internal volume may be taken.

Furthermore, the internal volume of an enclosure necessary to determine the depth of the gap and the gap shall be the internal volume of the enclosure itself subtracted by the volume of the contents of the enclosure indispensable for the operation.

Table 4. Depth of Gap and Gap between Joint Surfaces Fixed or Moving only Occasionally

Unit: mm

Internal volume Depth of gap and gap		Up to 2 cm ³ incl. ⁽²⁾	Over 2 cm ³ to 100 cm ³ incl.	Over 100 cm ³ to 500 cm ³ incl.	Over 500 cm ³ to 2000 cm ³ incl.	Over 2000 cm ³ ⁽³⁾	
Permissible min. value of depth of gap L	Fixed part	5	5	8	15	25	40
	Part which moves only occasionally	5	10	15	20	25	40
Permissible min. value of shortest distance L_1 to bolt hole		5	5	6	8	10	15
Permissible max. value of gap w		0.3	0.3	0.3	0.3	0.3	0.5

Notes ⁽²⁾ As for the enclosure having internal volume 2 cm³ or less, if the construction of the joint surfaces is screwed mutually or occluded, it is, generally, certified that flame escape is prevented securely by such construction alone.

- (³) As for the enclosure having internal volume over 2000 cm³, in the case where the maximum gap (W) is a certain value between 0.3 and 0.5, the values L and L_1 shall be calculated proportionately from the value of the Table 4.

6.2.2 Rotating Shaft The depth of the gap and the gap of a rotating shaft shall be as follows:

- (1) The depth of the gap and the gap of a rotary shaft and other part which rotates during operation shall conform to Table 5 in accordance with the internal volume of an enclosure. When required due to construction, however, the value of a larger compartment of the internal volume may be taken.

The internal volume necessary to determine the depth of the gap and the gap shall be the internal volume of the enclosure itself subtracted by the volume of contents indispensable for the operation.

Table 5. Depth of Gap and Gap for Rotating Shaft

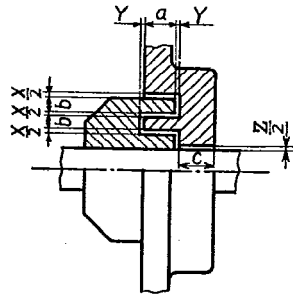
Unit: mm

Internal volume			Up to 2 cm ³	Over 2 cm ³ to 100 cm ³ incl.	Over 100 cm ³ to 500 cm ³ incl.	Over 500 cm ³ (⁴)	
Depth of gap and gap							
Class of bearing	Ball and roller bearing	Permissible min. value of depth of gap L	5	10	15	25	40
		Permissible max. value of gap W	0.45	0.45	0.45	0.45	0.6
	Sliding bearing	Permissible min. value of depth of gap L	5	15	25	40	
		permissible max. value of gap W	0.3	0.3	0.3	0.5	

Note (⁴) As for the enclosure having internal volume over 500 cm³, when the maximum gap (W) is between 0.45 and 0.6, the value of L shall be calculated proportionately from the value of the Table 5.

- (2) Examples how to take the depth of the gap L and the gap W in labyrinth construction are given in formulae (1), (2) and (3) in Fig. 1.

Fig. 1. How to Take L in Labyrinth Construction



- (1) when $X \leq W$ $Y \leq W$ $Z \leq W$,

$$L = \Sigma(a+b)+c$$
(2) when $X \leq W$ $Y \leq 3W$ $Z \leq W$,

$$L = \Sigma a + c$$
(3) when $X \leq W$ $Y > 3W$ $Z \leq W$,

$$L = a \text{ or } c$$

6.2.3 Finishing Grade of Joint Surfaces The finishing grade of joint surfaces shall be equivalent to or superior to 25 S of JIS B 0601.

Furthermore, on the joint surfaces for the sake of rust proofing and water proofing, non-dry oil may be given.

6.2.4 Materials Constituting Joint Surfaces The materials constituting joint surfaces of an enclosure shall, as a rule, be metallic, and even when the enclosure is constructed with materials other than metals, at least one of the joint surfaces shall be metallic.

6.3 Screw and Screwed Joint

6.3.1 Clamping Screw and Screwed Joint Necessary for Maintaining Explosion-Proof Property The clamping screw and screwed joint (including a screwed lid) necessary for maintaining the explosion-proof property shall be provided with locking and retaining means to prevent loosening. This is not applicable, however, to the screwed joint between enclosures or between an enclosure and a pipe or the like which is not liable to loosen due to construction with both ends firmly fixed or by other means.

6.3.2 Strength of Screws and Number of Screws Clamping screws or the like for connecting an enclosure shall have strength sufficient to withstand explosion pressure.

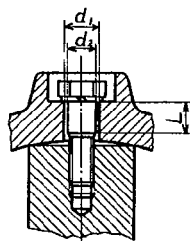
Furthermore, when screws alone are used for connection, 3 or more screws shall, as a rule, be used.

6.3.3 Penetrating Screws or the Like Penetrating screws or the like shall be as follows:

- (1) Screws or the like may penetrate the wall of enclosure only when unavoidable. In this case, the penetrating screw or bolt shall be provided with locking and means to prevent loosening.
- (2) The fitting part between the penetrating screw and the enclosure shall conform to 6.3.4.

- (3) When a penetrating hole is a loose through hole as shown in Fig. 2, the portion of a screw or bolt which passes the hole shall not be threaded and its length and difference in diameter shall conform to the values L and W in Table 4.
- (4) In the case of non-penetrating screws, the wall of the enclosure shall have a thickness left sufficient to withstand the explosion pressure at the time of an explosion.

Fig. 2. Penetrating Hole



$$(d_1 - d_2 \leq W)$$

6.3.4 Portion of Engaged Threads When giving the flame-proof enclosure explosion-proof property to the portion of engaged threads, the following shall be conformed to:

- (1) The type of threads shall be triangle threads having a thread angle of 60° or 55° .
- (2) The pitch shall be 0.7 mm or more. When it exceeds 2 mm, however, special consideration shall be given to prevent flame escape.
- (3) The number of engaged threads shall be not less than 5 continuous threads.
- (4) The length of engaged threads shall be 5 mm or more in the case of 100 cm^3 or less, or 8 mm or more in the case of over 100 cm^3 corresponding to the internal volume of an enclosure.

6.4 Packing

6.4.1 Packing Used at Part to be Opened A packing used at such part as to be opened for the purpose of operation, supervision or checking shall not be used as a means to prevent flame escape. Consequently, in this case it is necessary to maintain the depth of the gap and the gap as specified in Table 4, even if a packing falls off.

6.4.2 Packing Used at Part Not to be Opened For such part as not to be opened for the purpose of operation, supervision or checking, a packing may be used as a means to prevent flame escape, provided that it has adequate resistance and durability. In this case, a packing shall be made of metal or other non-combustible materials and shall be so made as not to be pushed out by explosion pressure.

To the dept of joint surfaces where a packing is used, the value of L of Table 4 shall apply. However, when a packing is constantly pressed with adequate pressure, the value of L_1 of Table 4 may be applied.

6.5 Limit of Temperature Rise A temperature rise at the outer surface of an enclosure shall not exceed 160°C.

7. Narrow Gap Explosion-Proof Construction

Items other than those specified in this paragraph shall conform to the specifications in 6. However, in an enclosure of the narrow gap explosion-proof construction, make and break contacts and windings may be immersed in oil.

7.1 Dimensions of Narrow Gap When a metallic flat plate is used, the dimensions of a narrow gap shall be not more than 0.5 mm for the gap and not less than 50 mm for the depth.

7.2 Gap Plate A gap plate shall be made of a metallic plate, for which an easily corrosive metal or an easily melting metal shall not be used. The thickness of a plate shall be not less than 2.0 mm for an opening area of 60 mm² or less per 1 l of internal volume, and not less than 1.0 mm for over 60 mm².

7.3 Gap Plate Layers A gap plate layer shall be firmly constructed so as not to be deformed by explosion pressure and shall be suitably protected from outside damage.

Furthermore, a gap plate layer shall be able to be removed as one block so as not to get deformed in the case of mending. If it is able to remove it from outside, however, it shall be provided with locks, and when the width of a gap opening is too wide, the gap plate is liable to be deformed by explosion pressure; therefore, it is recommended to make the width to 70 mm or less by means of a spacer or the like.

7.4 Strength of Enclosure An enclosure shall be so designed as to have the strength withstanding the test pressure given in Table 6. In the enclosure whose internal volume is over 100 l, an opening area per 1 l of internal volume shall be made 60 mm² minimum so as not to give undue thermal effects to the gap plate at the time of explosion.

Table 6. Value of Test Pressure for Narrow Gap Construction

Opening area (mm ²) Internal volume (l)	Test pressure kgf/cm ² {kPa}
10 and under	7.0 {686}
Over 10 to 20 incl.	4.5 {441}
Over 20 to 30 incl.	3.5 {343}
Over 30 to 40 incl.	2.0 {196}
Over 40 to 50 incl.	2.0 {196}
Over 50 to 60 incl.	1.5 {147}
Over 60 to 70 incl.	1.0 { 98}
Over 70 to 80 incl.	0.8 { 78}

Remark: In narrow gap construction for the enclosure of a battery, the space existing in normal operation shall be taken up in the calculation of an interval volume.

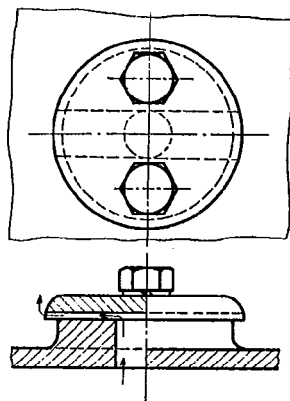
8. Oil-Immersed Explosion-Proof Construction

8.1 Enclosure

8.1.1 Construction of Enclosure The construction of an enclosure shall be the totally enclosed construction.

8.1.2 Gas Release Hole An oil-immersed switch or controller of over the rated making and closing capacity of 1 kVA or the interrupting capacity of 25 kVA shall be provided with a gas release hole shown in an example in Fig. 3. However, when the accumulation of oil gas cracked by sparks or arcs inside an enclosure is obviously little because of particular construction of the enclosure, it is unnecessary to provide specially a gas release hole.

Fig. 3. Construction of Gas Release Hole



8.1.3 Non-Oil-Immersed Part The non-oil-immersed part of an electric apparatus of the oil immersed explosion-proof construction shall conform to 7. or 10.

8.1.4 Oil Drain Device When mounting an oil drain device to an oil tank, it shall be of adequately tight construction to prevent oil leakage and shall be provided with a lock and a retaining means to prevent its loosening.

8.1.5 Indication of Oil Level An oil tank shall be provided with an oil level indicator or shall be so constructed as to permit easy observation of the oil level from outside.

8.1.6 Lowest Permissible Oil Level A sufficient distance shall be taken from the oil level to an ignition source so as not to cause sparks or arcs to rise above the oil surface, when oil leakage occurs due to damage of the oil level indicator. This distance shall be not less than 10 mm, no matter how small an electric apparatus is.

8.1.7 Marking of Oil Level on Inner Surface In such construction that an oil tank is dismantled for filling oil, the required oil quantity shall be marked on the inner surface of the oil tank.

8.2 Oil Level Indicator The construction of an oil level indicator shall be as follows:

- (1) The oil level indicator shall be of construction with the least possibility of breakage and to permit easy replacement of the transparent plate or tube.
- (2) The transparent plate or tube and packing of the oil level indicator shall not cause harmful changes by the action of hot oil.
- (3) The indicating range of the oil level indicator shall be wide enough to allow observation from outside, even when the oil level fluctuates due to temperature changes.

8.3 Lead-in Conductors

8.3.1 Classes of Lead-in Conductors When a lead-in conductor is in contact or liable to come in contact with oil, an oil resisting conductor shall be used.

8.3.2 Prevention of Oil Leakage through Lead-in Conductor When there is the risk of oil leakage through a lead-in conductor due to capillary action, measures to prevent oil leakage shall be positively taken.

8.3.3 Insulation of Part of Conductor Passing through Oil Surface In a switch or controller when the voltage of a live part against earth exceeds 1 kV, the live part of a conductor passing through the oil surface shall be insulated with covering.