

JIS

JAPANESE INDUSTRIAL STANDARD

**Electrical Apparatus for
Explosive Atmospheres in
General Industry**

JIS C 0903—1983

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JAPANESE INDUSTRIAL STANDARD

J I S

Electrical Apparatus for Explosive
Atmospheres in General Industry

C 0903-1983

1. Scope

This Japanese Industrial Standard specifies explosion-protected construction of electrical machinery and appliances, hereinafter referred to as the "electrical apparatus", which are used independently or as a part of other machine or an installation in hazardous area due to gas or vapour ⁽¹⁾.

The intrinsically-safe construction also applies to the construction of the intrinsically-safe apparatus and associated apparatus which are used in non-hazardous areas. This standard, however, is not applicable electrical apparatus for coal mine and those for ships.

Note ⁽¹⁾ The hazardous area referred means such area in factories or the like where explosive atmosphere is likely produced due to mixing of enough explosive gases with air to cause explosion or burning, and classified into zone 0, zone 1 and zone 2.

Remark: The units and numerical values given in { } in this standard are in accordance with the International System of Units (SI) and are appended for reference.

2. Definitions

For the purpose of this standard the following principal definitions shall apply.

- (1) enclosure An enclosure such as outside frame of rotating machinery, outside vessel of transformer and switch, by which explosion-protected construction is achieved.
- (2) shroud To make loosening of clamped part impossible without use of a special tool.
- (3) zone 0 A place where hazardous atmosphere is continuously present or present for long periods under ordinary state.
- (4) zone 1 A place where hazardous atmosphere is likely to occur under ordinary state.
- (5) zone 2 A place where hazardous atmosphere is likely to occur under abnormal state.

Applicable Standards, Corresponding International Standard, and Reference Standards: See page 40.

(6) gap and length of flame path

- (a) The gap means the maximum gap between the corresponding surfaces at a fit or joint, or the maximum difference between diameter of a hole and that of shaft or rod, in a flameproof enclosure under ordinary state without pressure applied to the interior.
 - (b) The length of flame path means the minimum length of gap part in a flameproof enclosure where the gap is kept within the permissible value.
- (7) creepage distance The minimum distance between a bare live part and other part to be insulated from the live part, along the surface of insulating material through which a leakage current might appear.
- (8) clearance The minimum distance between a bare live part and other part to be insulated from the live part through air.
- (9) explosive gas This is the generic term given to flammable gas or vapour of flammable liquid, and includes both cases that such gas exist independently or mixed in air.
- (10) hazardous atmosphere An atmosphere in which explosive gas is mixed with air within explosive limits.
- (11) source of ignition An electric spark or high-temperature part which has energy enough to cause explosion of hazardous atmosphere.
- (12) transparent window A window which is a part of enclosure and employs a transparent plate to observe interior of the enclosure.
- (13) transmission of flame This term means such phenomenon that flame, high-temperature gas and the like caused by internal explosion in a flameproof enclosure pass through joint surfaces and ignite the ambient explosive gas.
- (14) protective gas The clean air or inert gas used for maintaining inside pressure of enclosure at a certain value in a pressurized enclosure.
- (15) purging The operation of passing protective gas through the enclosure and ducts of an explosion-protective construction of pressurized type so as to eliminate the explosive gas entered during rest period of voltage application.
- (16) terms used for intrinsically-safe construction
- (a) intrinsically-safe circuit An electric circuit in which it is verified that electric spark and high-temperature part is incapable of causing ignition of explosive gases when examined in accordance with the test conditions and method specified in 4.5 of JIS C 0904.
 - (b) non-intrinsically-safe circuit Electric circuits other than intrinsically-safe circuit.

- (c) intrinsically-safe apparatus An electrical apparatus in which all the circuits are of intrinsically-safe.
- (d) associated apparatus An electrical apparatus which is so designed that the specification necessary for keeping intrinsic safety against explosion of the intrinsically-safe circuits connected directly or indirectly to the apparatus is satisfied.
- (e) infallible component An electrical component used for keeping intrinsic safety of an electric circuit and satisfies prescribed specification.
- (f) infallible circuit An electrical circuit which has such function that limits the voltage, current or both of them, and which is composed of components including infallible components.
- (g) safety rating The rating which is determined for intrinsically-safe and associated apparatus, and is the maximum rating within which intrinsic safety against explosion of the related intrinsically-safe circuit is assured.
- (h) safety barrier assembly An associated apparatus which is mainly composed of infallible components and/or infallible circuits and which limits electric energy liable to ignite the gas flowing into the related intrinsically-safe circuit from non-intrinsically-safe circuits within its safety rating range.
- (i) segregation distance (distance through casting compound) The minimum distance between live parts the space between which is completely filled with such insulation as synthetic resin.

3. Ignition Category and Explosion Grade

For the explosive gas in general factories and the like, the ignition category and explosion grade are, according to its degree of danger, specified as follows:

- (1) Ignition Category The ignition categories of explosive gases are classified into the six categories as shown in Table 1, according to the ignition temperatures.

Table 1. Classification of Ignition Categories

Unit: °C

Ignition category	Ignition temperature
G1	Over 450
G2	Over 300 to 450 incl.
G3	Over 200 to 300 incl.
G4	Over 135 to 200 incl.
G5	Over 100 to 135 incl.
G6	Over 85 to 100 incl.



- (2) Explosion Grade The explosion grades are classified into three grades as shown in Table 2, according to the minimum values of gap which permits the flame propagation in the test made with a standard test vessel.

Table 2. Classification of Explosion Grades

Unit: mm

Explosion grade	The minimum value of gap which permits flame propagation at a length of flame path of 25
1	Over 0.6
2	Over 0.4 to 0.6 incl.
3	0.4 max.

4. Classification of Explosion-Protected Construction

4.1 Flameproof Type The flameproof type means such enclosed construction that the enclosure withstands internal explosion of explosive gases, if occurred, and that the external explosive gases will not be ignited.

4.2 Oil Immersed Type The oil immersed type means such construction that the parts of electrical apparatus on which sparks or arcs may occur are immersed into oil so that explosive gases existing above the surface of the oil will not be ignited.

4.3 Pressurized Type The pressurized type means such construction that the inside of enclosure is maintained at an overpressure by pressurizing the protective gas (clean air or inert gas) so as to prevent the introduction of explosive gases.

This type is divided into the continuous type, compensating type and hermetically-sealed types according to the way of maintaining the overpressure.

4.4 Increased Safety Type The increased safety type means a construction in which additional measures are applied so as to give increased security against the possibility of excess temperature and of the occurrence of electric sparks at the part of apparatus where such abnormality must not occur in normal service.

4.5 Intrinsically-safe Type The intrinsically safe type means a construction in which it is verified by the ignition test or in other ways that any spark or high temperature part produced either normally or in specific fault conditions is incapable of igniting explosive gases.

4.6 Special Type The special type means a construction other than those prescribed in 4.1 to 4.5, in which it is verified that prevention of igniting explosive gas is capable by the test or in other ways.

5. Symbol of Explosion-Protected Construction

As for classification of explosion-protected construction, explosion category and ignition grade, their symbols are specified as given in Table 3.

Table 3. Symbol of Explosion-Protected Construction

Classification		Symbol
Type of explosion-protected construction	Flameproof type	d
	Oil immersed type	o
	Pressurized type	f
	Increased safety type	e
	Intrinsically-safe type	i
	Special type	s
Explosion grade	Explosion grade 1	1
	Explosion grade 2	2
	Explosion grade 3	3 a
		3 b
		3 c
		3 n
Ignition category	Ignition category G 1	G1
	Ignition category G 2	G2
	Ignition category G 3	G3
	Ignition category G 4	G4
	Ignition category G 5	G5
	Ignition category G 6	G6

- Remarks 1. In intrinsically-safe electric apparatus, notation a or b is added just following the symbol i, to identify category a or category b.
2. In explosion grade 3, 3 a means water gas and hydrogen, 3 b means carbon disulfide, 3 c means acetylene, and 3 n denotes all the gases in this grade.

6. Explosion-Protected Construction in General

6.1 General Requirements for Explosion-Protected Construction The requirements for explosion-protected construction is as follows:

- (1) The explosion-protected construction of electrical apparatus shall comply with this standard. However, even the other construction or materials than those specified in this standard are used in details of explosion-protected construction, if it is verified by the public authority by means of test or other ways that sufficient explosion protection is achieved, then such construction or materials may be employed.
- (2) The explosion-protected electrical apparatus shall, by taking the environmental conditions (for example, chemical effect by gas/vapour and the like) in the operating area into consideration, be so constructed that adequate strength and easy maintenance are ensured, and the materials used shall have enough resistibility against electrical, mechanical, thermal and chemical effects.

When accumulation of water due to moisture condensation within the enclosure of apparatus is anticipated, suitable measures shall be taken for prevention of moisture condensation or for the drainage.

6.2 Limit of Temperature Rise The limit of temperature rise shall be as follows:

- (1) In an electrical apparatus, the limit of temperature rise for a given explosive gas shall be as given in Table 4.

The limit of ambient temperature shall be 40°C.

Table 4. Limit of Temperature Rise

Unit: °C						
Ignition category	G1	G2	G3	G4	G5	G6
Limit of temperature rise	320	200	120	70	40	30

- (2) If the reference ambient temperature exceeds 40°C, the values of the limit of temperature rise given in Table 4 shall be reduced by the excess. In this case, the reference ambient temperature shall be marked on the electrical apparatus.
- (3) When cooling water or the like is used as the cooling medium, the necessary items such as the temperature and flow rate of the cooling medium which are taken as a condition to determine the limit of temperature rise, shall be marked.

- (4) Where the temperature rise is affected by heat conduction, heat radiation, etc. from relevant mechanical equipment and the like, the limit of temperature rise shall be determined with the condition of use clearly given. In this case, the condition of use shall be marked on the apparatus.
- (5) When the temperature rise is affected by the use and ratings or operating system, the necessary particulars shall be marked with such conditions clearly given.

6.3 Application of Explosion-Protected Electrical Apparatus

- (1) An electrical apparatus in which generation of electric arcs or sparks, or high temperature which serves as the source of ignition is anticipated in normal service shall have either one of the following types for its explosion-protected construction.
 - (a) Flameproof type
 - (b) Oil-immersed type
 - (c) Pressurized type
 - (d) Special type
- (2) An electrical apparatus in which generation of electric arcs or sparks, or high temperature which serves as the source of ignition is not anticipated in normal service may have increased safety type besides the types prescribed in (1) for its explosion-protected construction.
- (3) An electrical apparatus in which generation of electric arcs or sparks, or high temperature which serves as the source of ignition is not likely to occur in normal service and in fault condition and the safety is verified by the test or in other ways, may have intrinsically-safe type.

6.4 Marking of Explosion-Protected Construction Each explosion-protected electrical apparatus shall be marked in accordance with the particulars in respect with, explosion-protected construction prescribed below, besides the marking specified in relevant general rule for the electrical apparatus, at its easily visible place.

- (1) The type of explosion-protected construction, explosion category and ignition grade of explosive gas to which the apparatus is exposed shall be marked. However, for electrical apparatus of the construction applicable irrespective of explosion grade, the symbol of explosion grade is omitted.

The marking for oil-immersed type apparatus the enclosure of which is made flameproof enclosure in accordance with 8.1.4 shall be o (d).

- (2) When the explosive gas to which the apparatus is exposed is limited to particular one, the name of gas shall be clearly marked without carrying out marking by symbols denoting the explosion grade and ignition category.
- (3) For an electrical apparatus in which 2 or more types of explosion-protected construction are combined, the symbol of each type shall be marked. In this case, the symbol denoting the type of explosion-protection employed for the major part of apparatus shall be marked first.

Where it is required to indicate every type of explosion-protection on the component parts of apparatus, for the purpose of handling the apparatus or ensuring safety, each of the symbols involved shall, besides the marking above-mentioned, be marked on the corresponding part. In this case the explosion grade and ignition category are not marked on each part.

- (4) When the symbols concerning explosion-protection are indicated en bloc, they shall be indicated in the sequence of type of explosion-protection, explosion grade and ignition category.
- (5) If it is required to specify the conditions under which an explosion-protected electrical apparatus is used, the apparatus shall bear clear descriptions of the essential points.

6.5 Construction of Shroud

6.5.1 Application of Shroud The application of shrouding on the screws and the like which are components of an explosion-protected electrical apparatus shall be as follows:

- (1) All the screws and the like necessary for maintaining the explosion-protection performance which can be loosened from the outside shall be shrouded. However, the shrouding may be omitted for those screws and the like which are not required to be loosened except in disassembling and reassembling, which are not likely to be loosened by the others than responsible person, and which may cause little effect on the explosion-protection performance even when loosened.

Further, if the purpose of shrouding is completely achieved by applying the shrouds to some of the screws, the shroud for other screws may be omitted.

- (2) The screws or the like fastening lids and covers opening of which permits access to the internal live parts and might cause hazards, shall be shrouded at one or two points at least so as to prevent easy opening of such lids and covers. However, the shrouding may be omitted for those screws and the like which will not be loosened except disassembly or reassembly and which are not likely to be loosened by other person than the responsible person.

6.5.2 Construction of Shroud The shrouds shall be so constructed that they will not easily be loosened by ordinary tools such as screw drivers, spanners and pliers.

The construction and dimensions of shrouds for hexagon head bolts, socket head bolts, machine screws, etc. which are most generally used, are specified in Appendix 1.

6.6 Connection of External Conductor with Electrical Apparatus

6.6.1 Method of Connecting External Conductor with Electrical Apparatus
The connection of external conductor with electrical apparatus shall be made as follows:

- (1) The connection of external conductors with an electrical apparatus shall, as a rule, be made within the terminal box attached to the electrical apparatus. However, the connection may be made directly without using the terminal box in either of the following cases:
 - (a) When the explosion-protected construction of the electrical apparatus is of pressurized type.
 - (b) When the external conductors are in the scope of intrinsically-safe circuit, and when the conductors involved in a non-intrinsically-safe circuit are connected with an associated circuit located in non-hazardous area.
- (2) The connection of external conductor with electrical apparatus prescribed in (1) (a) shall be made in accordance with 6.6.5.
- (3) The connection of external conductor with electrical apparatus prescribed in (1) (b) shall be made in accordance with 6.6.6.

6.6.2 Terminal Box The terminal box shall be as follows:

- (1) The terminal box is attached to an electrical apparatus and used for connecting the external conductors.
- (2) The live parts within a terminal box shall be given increased safety in terms of the creepage distance and clearance connecting structure, temperature rise, etc. in accordance with the provision of 10.
- (3) The terminal box shall have sufficient internal space to permit connection of conductors.
- (4) Application of explosion-protected construction to terminal boxes shall be made as follows:

- (a) The terminal box of explosion-protected electrical apparatus of flameproof type, pressurized type, and of oil-immersed type having flameproof enclosure, shall have flameproof construction. However, terminal box of high-voltage electrical apparatus and the terminal box of low-voltage electrical apparatus of flameproof type, pressurized type and of oil-immersed type having flameproof enclosure which are used in zone 2 only and clearly marked thereof, may be of increased safety type.
- (b) The terminal box of explosion-protected electrical apparatus of oil-immersed type and increased safety type shall be of increased safety type. However, the terminal box of low-voltage electrical apparatus used in zone 1, shall be of flameproof type.
- (5) The construction of terminal box is specified in Appendix 2.

6.6.3 Entry of Conductor from Terminal Box into Main Body of Electrical Apparatus The entry of conductors from a terminal box into main body of the electrical apparatus shall be as follows:

- (1) Where the main body or terminal box of explosion-protected electrical apparatus is of flameproof type, the system used for entry of conductors shall be of the specified flameproof-stud type, flameproof-packing type (flameproof single-hole packing type and flameproof multi-hole packing type), or flameproof sealing type (including flameproof resin sealing type). However, the flameproof multi-hole packing type and flameproof sealing type conductor entries are applicable to low-voltage circuit only.
- (2) Where the main body is explosion-protected construction of other than flameproof type and the terminal box is of increased safety type in an explosion-protected electrical apparatus, the system used for entry of conductors shall be of the specified stud type, packing type (single-hole packing type and multi-hole packing type), sealing type, bushing type, or clamp type. However, the multi-hole packing type and sealing type conductor entries are applicable to low-voltage circuit only.
- (3) The construction of each conductor entry given in (1) and (2) is specified in Appendix 3.

6.6.4 Entry of External Conductor into Terminal Box The entry of external conductor into terminal box shall be as follows:

- (1) The system used for entry of conductors into a flameproof type terminal box shall be of the specified flameproof conduit type, flameproof packing type (single-hole one only), flameproof sealing type, or flameproof sleeve assembly type for MI cable.
- (2) The system used for entry of conductors into a increased safety type terminal box shall be of the specified conduit type, packing type (single-hole one only) or sealing type.
- (3) The construction of each conductor entry given in (1) and (2) is specified in Appendix 4.

6.6.5 Direct Entry of External Conductors into Pressurized Electrical Apparatus The direct entry of external conductors into pressurized electrical apparatus shall be as follows:

- (1) The direct entry of conductors into a pressurized electrical apparatus shall conform with 6.6.4 (2) as practical. However, when leading-in MI cables the flameproof sleeve assembly type for MI cable given in 6.6.4 (1) shall be employed.

If thick steel conduits are connected directly by means of the method given in conduit type, suitable sealing shall be applied.

- (2) Safety of the terminal part for connecting external conductor in a pressurized electrical apparatus shall be improved by designing the clearance, creepage distance, structure of joint, temperature rise, etc. in compliance with the provision of 10.

6.6.6 Direct Connection of External Conductor with Intrinsically-Safe Electrical Apparatus Direct connection of external conductor involved in intrinsically-safe circuit with intrinsically-safe electrical apparatus, and direct connection of external conductor involved in non-intrinsically-safe circuit with associated electrical apparatus located in non-hazardous areas, shall be as follows:

- (1) The connection of external conductors with an electrical apparatus shall be made by means of terminal block or connector provided on the electrical apparatus. The construction of joint part for this procedure is specified in 11.3.1.
- (2) If loosening of joint or escape of conductor due to excess external tension or own weight of conductor applied to the connected part of external conductor is anticipated, the external conductor shall be secured by providing a clamp or the like.

6.6.7 Entry of Conductor through Partition in Electrical Apparatus When an electrical apparatus is divided into two or more separate enclosures in its interior, and the conductors are led-in through the partition, the appropriate method corresponding to the explosion-protected construction of each enclosure given in 6.6.3 shall be applied as practicable.

When an electrical apparatus is composed by combining two or more electrical apparatus and a part of the conductors connecting them each other is exposed outside the apparatus, if the exposed part is very short, protected from external damage and recognized as inner wiring of the apparatus, the terminal boxes may be omitted by employing the entry systems of flameproof packing type, packing type, flameproof sealing type or sealing type corresponding the respective explosion-protected construction.

6.6.8 Grounding Terminal An explosion-protected electrical apparatus of metallic enclosure shall provide grounding terminals in the inside and outside of its terminal box in accordance with the following items of (1) and (2). However, external grounding terminal shall not be provided on a movable apparatus.

When metal conduit(s) are connected by threading and the conduit can substitute as the grounding conductor, the grounding terminal may be omitted.

The grounding terminals shall be separate ones from the mounting screws, mounting foundation bolts or the like, and the use of such components for both purposes is not allowed.

- (1) When the apparatus has a terminal box, the grounding terminals shall be as follows:
 - (a) The external grounding terminal may be provided on a part other than terminal box and shall be so constructed that secure connection of grounding conductor is ensured.
 - (b) The grounding terminals shall be equipped with a suitable device to prevent loosening.
 - (c) The grounding terminal shall not be mounted through a flameproof enclosure. However, such case that the hole is so closed that flameproof performance will not disappear i.e. securely screwed tap-end stud for example, is exempted from the above requirement.
 - (d) The grounding terminal shall be marked with the letter symbol E or an appropriate graphical symbol.
- (2) When direct entry of external conductors is employed for an explosion-protected electrical apparatus of pressurized type or intrinsically-safe type, the grounding terminals shall be as follows:
 - (a) The grounding terminals shall be provided on the inside and the outside of the electrical apparatus.
 - (b) A loosening preventive device and marking shall be provided in accordance with (1) (b) and (d) respectively.

7. Construction of Flameproof Type

7.1 Enclosure

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

- (1) The enclosure shall be capable of withstanding the internal pressure correlating with its internal volume given in Table 5.

Where the internal volume of the enclosure does not exceed 2 cm^3 , the strength, however, need not exceed that necessary for fabrication and intended use.

Table 5. Internal Pressure (Gauge Pressure)

Internal volume Explosion grade	Over 2 cm ³ to 100 cm ³ incl.	Over 100 cm
1	8 kgf/cm ² {785 kPa} min.	10 kgf/cm ² {981 kPa} min.
2		
3	1.5 times or more the measured explosion pressure in preliminary explosion test, but at least 8 kgf/cm {785 kPa}	1.5 times or more the measured explosion pressure in preliminary explosion test, but at least 10 kgf/cm {981 kPa}

Remark: The preliminary explosion test here referred means an explosion test carried out to determine the test pressure, this explosion test is carried out under ordinary pressure on the enclosure of apparatus to be tested using an explosive gas for which the enclosure is designed, and the maximum explosion pressure occurred at the time shall be measured.

- (2) The internal volume necessary for determining the strength of enclosure is the remainder of the internal volume of enclosure itself deducted by the volume of its contents indispensable to operation.
- (3) Such construction that the interior of enclosure is divided into two or more compartments and connected by a small hole, shall be avoided. If such construction is unavoidably employed, the enclosure shall be designed to withstand the actual test pressure even if 1.5 times the actually measured pressure in the explosion test of the enclosure exceeds the appropriate value given in Table 5.

7.1.2 Content of Enclosure In the interior of enclosure, make-break contacts and windings shall not be immersed into oil.

7.1.3 Transparent Window The location of transparent windows shall be minimized, and the area of each opening shall not exceed 100 cm².

The transparent window shall be so constructed that its replacement is capable.

The transparent plate used for the transparent window shall be as follows:

- (1) The tempered glass specified in JIS R 3206 or a flame retardant material at least equal in the strength shall be used as the transparent plate, and the plate shall safely withstand the temperature rise attained on one surface at the time of explosion.

- (2) The transparent plate fitted to the transparent window shall have a strength to withstand the impact caused by a steel ball of 200 g in mass falling from a height of 200 cm, without damage.
- (3) The transparent plate shall be mounted so as to avoid undue internal stress.

7.2 Length of Flame Path and Gap

7.2.1 Joint Surface The length of flame path and gap between surfaces at a joint shall be as follows:

- (1) The length of flame path shall be designed as long as practicable, the gap as small as practicable, and the joint surfaces shall be so constructed that the gap is not likely become larger due to the effects in service.
- (2) The length of flame path and gap at joint surfaces between which there is no relative motion in normal service (e.g. flange part, fitted part) or at joint surfaces between which there is only occasional relative motion in normal service (e.g. the part through which operating rod penetrates) shall be those corresponding to the internal volume of enclosure given in Table 6. However, if the construction requires, such dimensions may have those specified in the column of larger internal volume.

The internal volume of enclosure necessary for determining the length of flame path and gap is the remainder of the internal volume of enclosure itself deducted by the volume of its contents indispensable to operation.

Table 6. Length of Flame Path and Gap at Joint Surfaces where No or Occasional Relative Motion Exists

Unit: mm

Internal volume		Up to and incl. 2 cm ³	Over 2 cm ³ to 100 cm ³ incl.	Over 100 cm ³ to 2000 cm ³ incl.	Over 2000 cm ³	
Length of flame path and gap						
Minimum permissible value for length of flame path L		5	10	15	25	40
Minimum permissible value for shortest distance to bolt hole L_1		5	6	8	10	15
Maximum permissible value for W	Explosion grade 1	0.3	0.2	0.25	0.3	0.4
	Explosion grade 2	0.2	0.1	0.15	0.2	0.25
	Explosion grade 3	0.1	*	*	*	*

Remark: The mark * in the above Table means that the values in the space shall be 50 % of the gap at which the flame did not transmit by the test for ignition by explosion.

7.2.2 Rotating Shaft The length of flame path and gap at a rotating shaft or the like shall be as follows:

- (1) The length of flame path and gap at a rotating shaft or other parts which rotate in service shall be those corresponding to the internal value of enclosure given in Table 7. However, if the construction requires, such dimensions may have those given in the column of larger internal volume.

The internal volume of enclosure necessary for determining the length of flame path and gap is the remainder of the internal volume of enclosure itself deducted by the volume of its contents indispensable to operation.

Table 7. Length of Flame Path and Gap for Rotating Shaft

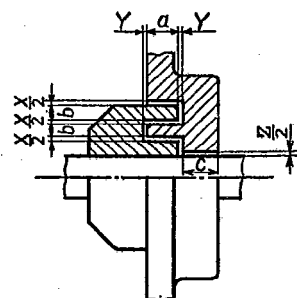
Unit: mm

Length of flame path and gap		Internal volume	Up to and incl. 2 cm ³	Over 2 cm ³ to 100 cm ³	Over 100 cm ³ to 500 cm ³	Over 500 cm ³		
Ball and roller bearing	Minimum permissible value for length of flame path <i>L</i>		5	10	15	25	40	
	Maximum permissible value for gap <i>W</i>	Explosion grade 1	0.45	0.3	0.45	0.45	0.6	
		Explosion grade 2	0.3	0.2	0.3	0.3	0.4	
		Explosion grade 3	0.15	*	*	*	*	
Sleeve bearing	Minimum permissible value for length of flame path <i>L</i>		5	15	25	40		
	Maximum permissible value for gap <i>W</i>	Explosion grade 1	0.3	0.2	0.3	0.5		
		Explosion grade 2	0.2	0.1	Not permissible			
		Explosion grade 3	0.1	*				

Remark: The mark * in the above Table means that the value shall be 50 % of the maximum gap at which the flame did not transmit in the test for ignition by explosion.

- (2) The relation between length of flame path L and gap W in a labyrinth construction is as shown in the formulae of (1), (2) and (3) given in Fig. 1.

Fig. 1. Manner of Taking L in Labyrinth Construction



- (1) If $X \leq W$ $Y \leq W$ $Z \leq W$

$$L = \Sigma(a+b) + c$$

- (2) If $X \leq W$ $Y \leq 3W$ $Z \leq W$

$$L = \Sigma a + c$$

- (3) If $X \leq W$ $Y > 3W$ $Z \leq W$

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

7.2.3 Surface Roughness of Joint Surface The surface roughness of joint surfaces shall have at least a degree of 25 S (designated with maximum height) specified in JIS B 0601. Non-drying oil or the like may be coated on the joint surfaces to prevent rust or ingress of water.

7.2.4 Material for Constituting Joint Surface The joint surfaces of an enclosure shall be metal-to-metal as a rule and even when materials other than metal are employed for an enclosure, at least one side of the joint surfaces shall be of metal.

7.3 Screw and Threaded Joint

7.3.1 Clamp Screw and Threaded Joint Necessary for Keeping Flameproof The clamp screws and threaded joints (including threaded covers) necessary for keeping flameproof performance shall be shrouded and equipped with a loosening preventive device. However, threaded joint between enclosures or an enclosure and pipe or the like which has no possibility of working loose based on its construction e.g. both sides are fixed may not follow the above requirement.

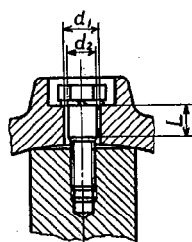
7.3.2 Strength and Number of Screws When screws or the like are used for securing parts of flameproof enclosure, they shall have strength enough to withstand the explosion pressure.

If a joint is made with screws or the like only, three or more screws shall be used, as a rule.

7.3.3 Screw or the Like which Passes through Enclosure Wall The screws or the like which pass through enclosure wall shall be as follows:

- (1) The screws or the like may pass through the enclosure wall only when such a mean is unavoidable. In this case, the through screws or bolts shall be shrouded and prevented from working loose.
- (2) The engagement of the thread on the through screw and enclosure thread shall be as given in 7.3.4.
- (3) When the through hole is a loose hole as illustrated in Fig. 2, the part of screw facing to the hole wall shall not be threaded and the length and diametrical clearance of this part shall meet the appropriate values given as L and W in Table 6, respectively.
- (4) When blind screws are used, the enclosure wall shall retain sufficient thickness to withstand the explosion pressure attained during explosion.

Fig. 2. Through Hole



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

7.3.4 Thread Engagement If the flameproof performance is relied upon the thread engagement, the engagement shall be as prescribed below. Provided that, application of thread engagement for enclosures of ignition grade 3 is limited for those not exceeding 6000 cm³ only.

- (1) As for the type of screws, the screws shall have triangular screw threads with an included angle of 60° or 55°.
- (2) The pitch shall be not less than 0.7 mm. However, when the pitch exceeds 2 mm, special consideration shall be taken into the design to prevent propagation of flame.
- (3) Special consideration shall be given on the grade of screw thread according to the type of screw and the explosion grade of the enclosure.
- (4) The threaded joints shall have a minimum of five full threads engaged for enclosures of explosion grade 1 and explosion grade 2, and of six full threads for enclosures of explosion grade 3.
- (5) The length of thread engagement shall be that given in correlation with the internal volume and explosion grade of enclosure in Table 8.

Table 8. Length of Thread Engagement

Unit: mm

Internal Ex- plosion grade	Up to and incl 100 cm ³	Over 100 cm ³
1 or 2	5 min.	8 min.
3	9.5 min.	12.5 min.

7.4 Gasket

7.4.1 Gasket Fitted on Part to Be Opened The gasket used on a part to be opened for the operation, inspection or maintenance shall not be employed as a means of preventing the flame propagation. Therefore, in such case it is necessary that the appropriate length of flame path and gap given in Table 6 are retained even if the gasket escapes.

7.4.2 Gasket Fitted on Part not to Be Opened Gasket, provided that they are sufficiently robust and durable, may be used as a means of preventing the flame propagation for the part not to be opened for the operation, inspection or maintenance. The gaskets shall be of metal or non-combustible material, and shall be so fitted that they are pressed with sufficient pressure and will not be pushed out by the explosion pressure. In this case, the appropriate value of L_1 given in Table 6 shall apply to the length of flame path of the joint with gasket.

7.5 Temperature Rise Limit The temperature rise at outside surface of enclosure shall not exceed the appropriate value given in Table 4.

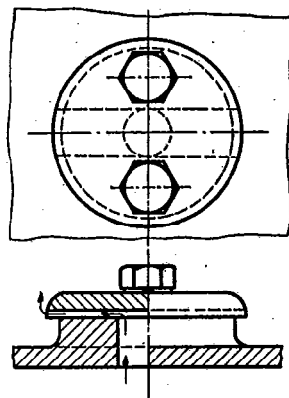
8. Construction of Oil-Immersed Type

8.1 Enclosure

8.1.1 Construction of Enclosure Totally enclosed construction shall be employed for the enclosure.

8.1.2 Gas Vent Oil immersed switches and controllers with a rated switching capability (rated voltage $\times$ rated normal current) over 1 kVA, or with an interrupting capability (rated voltage $\times$ rated short-circuit breaking current) over 25 kVA shall be equipped with a gas vent as illustrated in Fig. 3. However, the gas vent may not be equipped on an apparatus in which less accumulation of decomposed gases produced by the electric spark and arc is obviously recognized due to construction of the enclosure.

Fig. 3. Construction of Gas Vent



8.1.3 Part not Immersed into Oil In an oil-immersed type electrical apparatus, the part not immersed into oil shall comply with 10.

8.1.4 Exception on Enclosure Oil immersed manual switches with a rated voltage not exceeding 600 V, a rated switching capability up to 3 kVA (maximum switching capability up to 10 kVA) and without automatic release in which less accumulation of gases produced by decomposition of oil due to electric spark and arc is obvious may have flameproof enclosure. In such case, the apparatus may not follow the provisions of 7.1.2, 8.1.2 and 8.1.6, and the interior of enclosure may not follow the provision of 8.1.3.

Remark: The maximum switching capability (kVA) means the kVA which corresponds to the test current to be passed in the ignition test specified in 4.2.2 of JIS C 0904.

8.1.5 Oil Draining Device When an oil draining device is equipped on an oil tank, the joint shall be constructed so tightly that no oil leaks, and the fitting means shall be shrouded and prevented from loosening.