

**Coal Industry Standard of People's Republic of China**

MT/T 661-1997

**General technical condition for electrical apparatus used  
underground mine**

**MT/T 661-1997**

**Foreword**

This standard mainly refers to the following standards:

1. GB 3836 (electrical apparatus for explosive atmosphere), this standard mainly refers to the international standard IEC 79 Electrical Apparatus for Explosive Atmosphere.
2. GB/ T 14048.1 (general rules for low-voltage switchgear and control gear), this standard is equivalent to take the international standard IEC 947-1(1988) Low-voltage Switchgear and Control Gear – Part 1: General Rules and refers to take its amended and supplemented work piece.

This standard only specifies the general rules and basic requirements for the electrical apparatus used underground mine and the special requirements for various electrical products shall be additionally specified in various product standards respectively. This standard shall be used together with various product standards. If it conflicts with other industry standards, this standard shall prevail.

The appendix A, B and C in this standard are of the normative appendix.

This standard is proposed by the Science and Technology Education Department of the Ministry of Coal Industry.

This standard is under the jurisdiction of Coal Mine Special Equipment Standardization Technical Committee of the Ministry of Coal Industry.

Draft unit of this standard: Shanghai Branch of Coal Research Institute.

Participated Unit: Shanghai Mining & Electric Appliance Factory.

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This standard is commissioned to Shanghai Branch of the Coal Research Institute for the interpretation.

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## 1 Scope

This standard specifies the classification, technical requirement, test method, inspection rule, sign, packaging, transport and storage of the electrical apparatus used underground mine.

This standard is applicable for the electrical apparatus used underground mine (hereafter referred to as electrical apparatus), and specifies the general technical condition for electrical apparatus used underground mine.

## 2 References

The following standards contain provisions which, through reference in this standard, constitute provisions of this standard. The editions indicated are valid during the publication of this standard. All standards will be revised, and the parties who use this standard shall explore the possibility of using the latest version of the following standards.

|                        |   |
|------------------------|---|
| GB 156-93              | Standard voltage  |
| GB 191-90              | Packaging - Pictorial marking for handling of goods   |
| GB 311.1-83            | Insulation coordination of high-voltage power transmission equipment  |
| GB 311.2 - 311.6-83    | High voltage test techniques  |
| GB 762-80              | Rated current of electrical equipment   |
| GB/T 763-90            | Heating of AC high-voltage apparatus under long runs  |
| GB/T 998-82            | Basic testing method of low voltage apparatus   |
| GB 1984-89             | AC high voltage circuit breakers  |
| GB 1985-89             | AC high voltage isolating switch and grounding switch   |
| GB/T 2681-81           | Colors of insulated conductors used in electrical assembly devices  |
| GB/T 2682-81           | Colors of indicator lights and push-buttons used in electrical assembly devices   |
| GB/T 2706-89           | Test method of peak withstand current and short-time withstand current for high-voltage apparatus   |
| GB 2894-88             | Safety signs  |
| GB/T 3309-89           | Mechanical test for high-voltage switchgear at ambient temperature  |
| GB 3836.1 - 3836.4-83  | Electrical apparatus for explosive atmospheres  |
| GB 3836.5 - 3836.8-87  | Explosion-proof electrical apparatus for explosive atmospheres  |
| GB 3836.9 - 3836.10-87 | Explosion-proof electrical apparatus for explosive atmospheres  |
| GB/T 4026-92           | Identification of electric equipment terminals and of terminations of certain designated conductors, including general rules for an alphanumeric system |
| GB 4208-93             | Degrees of protection provided by enclosure (IP code)   |
| GB/T 4728.1-85         | Graphical symbols for electrical diagrams - General information   |
| GB/T 4942.1-85         | Classification of degrees of protection provided by enclosures  |
| GB/T 4942.2-93         | Degrees of protection provided by enclosures for low-voltage apparatus  |
| GB/T 5094-85           | Project code in electrical technology   |

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|-----------------|--|
| GB/T 7159-87    | General rules for the formulation of letter symbols in electrical technology   |
| GB/T 11022-89   | General technical conditions of high-voltage switchgear  |
| GB/T 12173-90   | Mining electrical apparatus for non hazardous area   |
| GB/T 14048.1-93 | General rules for low-voltage switchgear and control gear  |
| GB/T 14048.2-94 | Low-voltage switchgear and control gear - Low-voltage circuit breakers   |
| GB/T 14048.3-93 | Low-voltage switchgear and control gear - Low-voltage switches, disconnectors, switch-disconnectors and fuse-combination units |
| GB 14048.4-93   | Low-voltage switchgear and control gear - Low-voltage electromechanical contactors and motor starters                          |
| JB/Z 102-71     | Technical requirements of high-voltage electrical appliances used in the high-altitude region                                  |
| MT 154.2-1996   | Model establishment method and management method of electrical equipment for mine products                                     |
| MT 175-88       | Electronic protector intended to be used in flameproof electromagnetic starters used in mines                                  |
| MT 189-88       | Flame-proof type leakage detecting relay for coal mine   |
| MT 209-90       | General technical requirements of electric and electronic products for coal mine communication, detection and control          |
| ZB K35 006-89   | Mine explosion-proof high-voltage distribution device  |

### 3 Classifications

#### 3.1 Classified by rated voltage of electrical apparatus:

3.1.1 It is of the low-voltage electrical apparatus for the coal mine if the rated voltage is less than or equal to 1,200V (hereafter referred to as the low-voltage electrical apparatus).

3.1.2 It is of the high-voltage electrical apparatus for the coal mine if the rated voltage is greater than 1,200V (hereafter referred to as the high-voltage electrical apparatus).

#### 3.2 Classified by explosion-proof performance of electrical apparatus:

3.2.1 Mining electrical apparatus for non explosive atmospheres (hereafter referred to as the mining electrical apparatus)

3.2.2 Mine explosion-proof electrical apparatus (hereafter referred to as the explosion-proof)

3.2.2.1 Flame-proof electrical apparatus (hereafter referred to as the flame-proof)

3.2.2.2 Increased safety electrical apparatus (hereafter referred to as the increased safety)

3.2.2.3 Intrinsically safe circuits and electrical apparatus (hereafter referred to as the intrinsically safe)

3.2.2.4 Pressurized electrical apparatus

3.2.2.5 Oil filled electrical apparatus

3.2.2.6 Sand filled electrical apparatus

3.2.2.7 Encapsulated electrical apparatus

3.2.2.8 Hermetically sealed electrical apparatus

3.2.2.9 Special electrical apparatus

3.2.2.10 No sparking electrical apparatus

3.2.2.11 Complex electrical apparatus

#### 3.3 Classified by purpose of electrical apparatus:

3.3.1 Power Distribution Switch

3.3.1.1 Flameproof low-voltage feed switch

3.3.1.2 Flameproof low-voltage vacuum feed switch

3.3.1.3 Ordinary mine low-voltage power distribution switch (ordinary mine low-voltage switchgear)

3.3.1.4 Flameproof high-voltage power distribution device

3.3.1.5 Flameproof high-voltage vacuum power distribution device

3.3.1.6 Flameproof high-voltage line switch (isolation switch)

3.3.1.7 Ordinary mine high-voltage power distribution switch (ordinary mine high-voltage power distribution switchgear)

3.3.2 Control Switch

3.3.2.1 Flameproof low-voltage electromagnetic starter

3.3.2.2 Flameproof low-voltage vacuum electromagnetic starter

3.3.2.3 Flameproof and intrinsically safe electromagnetic starter

3.3.2.4 Flameproof and intrinsically safe low-voltage vacuum electromagnetic starter

3.3.2.5 Flameproof low-voltage hand-operated starter

3.3.2.6 Flameproof low-voltage hand-operated switch

3.3.2.7 Flameproof low-voltage plug switch

3.3.2.8 Flameproof high-voltage vacuum electromagnetic starter

3.3.2.9 Ordinary mine high-voltage vacuum electromagnetic starter

3.3.2.10 Mine explosion-proof electric control box

3.3.2.11 Mine flameproof and intrinsically safe electric control box

3.3.3 Control Circuit Switch

3.3.3.1 Flameproof low-voltage button

3.3.3.2 Flameproof low-voltage travel switch

3.3.3.3 Flameproof low-voltage deviation switch

3.3.3.4 Flameproof low-voltage foot switch

3.3.4 Accessories and Others

3.3.4.1 Flameproof low-voltage resistance box

3.3.4.2 Flameproof low-voltage electromagnet

3.3.4.3 Flameproof low-voltage meter box

3.3.4.4 Flameproof low-voltage latch

3.3.4.5 Flameproof low-voltage junction box

3.3.4.6 Integrated protection device for flameproof electric-drill transformer

3.3.4.7 Integrated protection device for flameproof lighting transformer

3.3.4.8 Flameproof low-voltage leakage relay

3.3.4.9 Flameproof high-voltage junction box

3.3.4.10 Increased safety high-voltage junction box

3.3.4.11 Intrinsically safe junction box

3.4 Classified by operation mode of electrical apparatus:

3.4.1 Hand-operated

3.4.2 Solenoid operated

3.4.3 Motor operated

3.5 Classified by arc-extinguishing medium of electrical apparatus:

3.5.1 Air

3.5.2 Vacuum

3.5.3 Sulfur hexafluoride

3.5.4 Lack of oil

3.5.5 Non-contact

#### 4 General Provisions

4.1 The electrical apparatus shall comply with this standard and the specification of respective product standards. It is necessary for the electrical apparatus to be delivered to the designated inspection unit in our country for the inspection in accordance with the regulation of relevant standard. Furthermore, it is necessary to be awarded with the conformity certificate of explosion-proof or conformity certificate of mine. For the products with the conformity certificate of explosion-proof or conformity certificate of mine, it is necessary to execute the inspection procedure again if other manufacturers manufacture the products.

4.2 The electrical apparatus shall comply with the type requirement specified in Table 1 according to the underground applied place. Otherwise, it is necessary to establish the safety measures, and report to the provincial (regional) Coal Board for the approval.

Table 1

| Type  | Use of Place  |  |                        |                        |                        |   |  |
|---|---|--|------------------------|------------------------|------------------------|---|--|
|   | Coal (Rock) and Gas Outburst Mine and Gas Outburst Area     | Gas Mine   |                        |                        |                        | Air Duct in Mine Area                                       | Total Return Air Duct, Main Return Air Duct, Working Surface and Working Intake Air, Return Air Duct |
|   |   | Total or Main Intake Airflow Roadway of Pit Bottom | Dumper Ketone Chamber  | Low Gas Mine           | High Gas Mine          |   |  |
| High and Low Voltage Motor and Electrical Apparatus | Mining Explosion-proof (Other Than Mining Increased Safety) | Ordinary Mining Type                               | Ordinary Mining Type   | Mining Explosion-proof | Mining Explosion-proof | Mining Explosion-proof (Other Than Mining Increased Safety) |  |
| Lighting  | Mining Explosion-proof (Other Than Mining Increased Safety) | Ordinary Mining Type                               | Mining Explosion-proof | Mining Explosion-proof | Mining Explosion-proof | Mining Explosion-proof (Other Than Mining Increased Safety) |  |

## Note:

1. The ordinary mining electrical apparatus may be used in the roadway that takes the for the overhead line electric car for the transport and the mechanical and electrical ketone chamber (including the lighting, communication, automation equipment and instrument and meter.
2. The mining increased safety motor may be used in the coal line and the main pump station of the pit bottom for the gas outburst mine.

- 4.3 The model of the electrical apparatus shall be prepared in accordance with the regulation of MT 154.2,
- 4.4 The rated voltage of the electrical apparatus shall comply with the regulation of GB 156. In general, the rated AC voltage is recommended to be 36V, 127V, (220V)<sup>1)</sup>, 380V, 660V, 1,140V, 3,300V<sup>2)</sup>, 6,000V and 10,000V.
- 4.5 The rated current of the electrical apparatus shall comply with the regulation of GB 762.
- 4.6 The rated frequency of the electrical apparatus is usually 50 Hz.
- 4.7 The electrical apparatus usually takes the 8h working system, and others are determined by respective product standard.
- 4.8 The electrical apparatus shall be provided with necessary fittings, accessories, dedicated tools and accompanying documents, which shall be two sets for important electronic plug-ins and one set for ordinary electronic plug-ins, for the convenience of the use, management and maintenance for users. The accompanying documents shall include the product certification, operation manual and packing list.

## 5 Technical Requirements

### 5.1 Environmental Conditions

- 5.1.1 Ambient Temperature: -5°C - 40°C, Atmospheric Pressure: 0.8 - 1.1 \* 10<sup>5</sup> Pa
- 5.1.2 Altitude: 2,000 m for the low-voltage electrical apparatus and 1,000 for the high-voltage electrical apparatus<sup>3)</sup>.
- 5.1.3 Monthly Mean Relative Humidity of Ambient Air: No more than 95% (25°C)。
- 5.1.4 The use in the place with the gas and coal dust explosion hazards shall comply with the regulation of section 4.2 in this standard.
- 5.1.5 In the gas or steam environments without the insulation damage.
- 5.1.6 The class of pollution is class 3.
- 5.1.7 The installation type is specified by the product standard.
- 5.1.8 It shall be able to undertake the vibration specified in Table 2 and the impact specified in Table 3 if there is the requirement for the vibration and impact during the use, installation, storage and transport in the place without obvious vibration and impact. Furthermore, its appearance and performance shall be in good state, which shall be noted during users' order.

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1) This voltage is applied less.

2) There is not this voltage level in GB 156 for it is of the special use level for the Ministry of Coal.

3) Relevant parameters shall be converted in accordance with the standard specified in JB/Z 102-71 when it is out of the altitude 1,000 m for the high-voltage electrical apparatus.

Table 2

| Product   | Vibration Frequency (Hz) | Acceleration Amplitude <sup>1)</sup> (m/s <sup>2</sup> ) | Displacement Amplitude <sup>2)</sup> (mm) | Sweep Cycles of Each Axis Line | Sample State  |
|---|--------------------------|--|---|--------------------------------|---------------|
| Mounted in Coal Mine  | 10 - 150                 | 50   | 0.35                                      | 5                              | Not energized |
| Mounted in Locomotive and Mining Machinery  | 10 - 150                 | 50   | 0.35                                      | 5                              | Energized     |
| 1) It refers to the specified acceleration amplitude over the crossover frequency.  |                          |  |   |                                |               |
| 2) It refers to the specified acceleration amplitude under the crossover frequency. |                          |  |   |                                |               |

Table 3

|  | Peak Acceleration (m/s <sup>2</sup> ) | Pulse Duration (ms) | Sample State  |
|--|---------------------------------------|---------------------|---------------|
| Mounted in Coal Mine                       | 500                                   | 11                  | Energized     |
| Mounted in Locomotive and Mining Machinery | 500                                   | 11                  | Not energized |

5.1.9 The electrical apparatus that complies with the packaging requirement shall undertake the following transport test: The packaged electrical apparatus is mounted to the middle and rear part of the trucks and fixed appropriately, and travels for 200 km in the level-3 road surface at the speed 25 km/h-40 km/h. There is not any obvious damage or deformation for the packing list after the transport, and there is not any damage for the internal products and they operate normally. It is allowed to place the electrical apparatus with the complete package into the simulated test bench for automobile transportation.

## 5.2 Requirement for Structure and Explosion-proof

### 5.2.1 Enclosure Material

The material for the explosion-proof enclosure shall comply with the regulation of GB 3836.1 Plastic Enclosure and Light Aluminum Alloy Enclosure and GB 3836.2 Flame-proof Enclosure respectively in accordance with different explosion-proof type and use of places. The material for the mining ordinary enclosure shall comply with the regulation of GB/T 12173.

### 5.2.2 Impact Strength of Enclosure

The enclosure shall comply with the regulation of GB 3836.1 Impact Test. For the impact energy, refer to Table 4.

Table 4

| Type of Sample  | Degree of Mechanical Hazard |     |
|---|-----------------------------|-----|
|   | High                        | Low |
| Plastic Enclosure or Enclosures, Light Alloy of Parts, Cast Iron Enclosure, Other Metal Enclosure Protective Cover or Protective Net  | 20                          | 7   |
| Transparent Parts without Protection  | 10                          | 4   |
| Transparent Parts with Protection   | 4                           | 2   |
| Note: For the selection of the high and low column, select the high column for the flame-proof type usually. If the low column is selected, it is necessary to add the mark X behind the certificate of conformity number for the explosion-proof. And other type work piece shall be selected in accordance with the regulation of respective product standards. |                             |     |

### 5.2.3 Degree of Protection for Enclosure



The degree of protection for the enclosure shall comply with the regulation of GB 3836.3 Degree of Protection for Enclosure in accordance with different explosion-proof types and use of places, the intrinsically safe enclosure shall comply with the regulation of GB 3836.4 Enclosure, and the mining ordinary enclosure shall comply with the regulation of GB/T 12173 Degree of Protection.

5.2.4 Fastening of Enclosure and Fasteners

The fasteners of the explosion-proof equipment other than the intrinsically safe enclosure shall comply with the regulation of GB 3836.1 Fasteners. The fasteners of the flame-proof enclosure shall comply with the regulation of GB 3836.2 Fastening of Enclosure. The mining ordinary enclosure shall comply with the regulation of GB/T 12173 Fasteners.

5.2.5 Marking, Interlocking and warning Signs

5.2.5.1 It is necessary to set the clear marking in the obvious places for the enclosure of the electrical apparatus used in underground mine. Furthermore, it shall comply with GB 3836.1 Marking section, and the mining ordinary electrical apparatus shall comply with GB/T 12173 Marking section.

5.2.5.2 The interlocking device of the electrical apparatus used in underground mine shall be designed as the structure that the common tools can not release its interlocking functions.

5.2.5.3 It is necessary to set the interlocking device for the electrical apparatus that will cause the spark or arc during the normal operation. The cover of the enclosure shall not be opened when the power supply switches on. The power supply shall not switch on after the cover of the enclosure is opened. The enclosure fastened by the bolt is allowed to be replaced with the warning sign, and the warning sign is marked with Open Cover of Enclosure after Power Off.

5.2.5.4 It is necessary to set the protective cover with the degree of protection no lower than IP20 for the electrical apparatus whose DC voltage is higher than 60V and the AC voltage is higher than 36V if it may contact the live parts when the cover is opened or the spare parts of the electrical apparatus is removed. Furthermore, it is necessary to set the Care about Electric Shock warning sign in accordance with GB 2894.

5.2.5.5 For the structure interlocked with the isolation switch, it is necessary to ensure the contact disconnected position is visible or the status of the contact may be judged correctly by the position of the handle.

5.2.5.6 The electrical apparatus used in the underground mine with the capacitor, electric heater and the quick activated door or cover shall be set with the warning sign with the time interval. Furthermore, it shall comply with the Overview section of GB 3836.1 General Provisions.

5.2.6 The cable entry shall be selected by different types and the mining ordinary device shall comply with the regulation of GB/T 12173 Cable Entry, the explosion-proof other than the intrinsically safe shall comply with the regulation of GB 3836.1 Cable Entry and the flame-proof device shall comply with the test regulation of GB 3836.2 Cable Entry.

5.2.7 Clearance and Creepage Distance

The clearance and the creepage distance between different potentials of the inlet and outlet terminal of the electrical apparatus shall comply with the regulation in Table 5.

Table 5

| Rated Voltage (V) | Clearance (mm) | Creepage Distance (mm) |   |   |   |
|-------------------|----------------|------------------------|---|---|---|
|                   |                | a                      | b | c | d |
|                   |                |                        |   |   |   |

|               |     |     |     |     |    |
|---------------|-----|-----|-----|-----|----|
| 36            | 4   | 4   | 4   | 4   | 4  |
| 60            | 6   | 6   | 6   | 6   | 6  |
| 127           | 6   | 6   | 7   | 8   | 10 |
| 220           | 6   | 6   | 8   | 10  |    |
| 380           | 8   | 8   | 10  | 12  |    |
| 660           | 10  | 12  | 16  | 20  |    |
| 1,140         | 18  | 24  | 28  | 35  |    |
| 3,000 (3,300) | 36  | 45  | 60  | 75  |    |
| 6,000         | 60  | 85  | 110 | 135 |    |
| 10,000        | 100 | 125 | 150 | 180 |    |

Note:

1. The voltage of the electrical apparatus may be 10% higher than the value list in the table above.
2. The a, b, c and d working is the classification of the insulation material by the relative tracking index. For the details, refer to Table 6.
3. The clearance and the creepage distance between the bare conductors of the intrinsically safe circuits and non-intrinsically safe circuits shall be greater than 50.
4. The minimum clearance of the bulb whose rated voltage is higher than 250V to mount the light is 3mm, and the Edison-base lampholder shall take the level A insulation material with the minimum creepage distance 3mm.
5. The mining electrical apparatus whose voltage is higher than 127V shall not take the phenolic plastics products.

Table 6

| Level | Relative Tracking Index | Test Voltage (V) | Number of Drops |
|-------|-------------------------|------------------|-----------------|
| a     |                         | 600              | > 100           |
| b     | 500                     | 500              | > 50            |
| c     | 380                     | 380              | > 50            |
| d     | 175                     | 175              | > 50            |

### 5.2.8 Grounding Device

The electrical apparatus shall be set with the dedicated grounding device and comply with the regulation of GB 3836.1 Grounding. The intrinsically safe electrical apparatus shall comply with the regulation of the circuit grounding, power supply transformer and barrier structure.

### 5.2.9 Damp Heat Test

The electrical apparatus shall be provided with the moisture resistance properties, the mining ordinary electrical apparatus shall comply with the regulation of GB/T 12173 Moisture Resistance Properties, and the explosion-proof electrical apparatus shall comply with the regulation of GB 3836.1 Damp Heat Test.

### 5.2.10 Surface Temperature

When the surface of the electrical apparatus may accumulate the dust, the allowed maximum surface temperature is +150°C. When some measures are taken to prevent the accumulation, the allowed maximum surface temperature is +450°C.

### 5.2.11 Mining Ordinary Electrical Apparatus

The electrical apparatus in the place without the gas and coal dust explosion risk in the coal mine may take the ordinary electrical apparatus with the marking ky. The meaning of the mining ordinary electrical apparatus is the non explosion-proof electrical apparatus manufactured for the coal mine dedicatedly.

The mining ordinary electrical apparatus shall comply with the standard GB/T 12173.

#### 5.2.12 Mining Flame-proof Electrical Apparatus

The electrical apparatus in the place with the gas and coal dust explosion risk in the coal mine may take the flame-proof electrical apparatus with the marking dI. In addition to comply with the standard GB 3836.2, the mining flame-proof electrical apparatus shall also comply with the regulation of the standard GB 3836.1.

#### 5.2.13 Mining Increased Safety Electrical Apparatus

The electrical apparatus in the pit bottom, total inlet air duct or main inlet air duct used in the coal mine may take the increased safety type with the marking eI (see Table 1).

In addition to comply with the standard GB 3836.3, the mining increased safety electrical apparatus shall also comply with the regulation of the standard GB 3836.1.

#### 5.2.14 Mining Intrinsically Safe Electrical Apparatus

The electrical apparatus in the place with the gas and coal dust explosion risk in the coal mine may take the intrinsically safe electrical apparatus with the marking iaI and ibI.

In addition to comply with the standard GB 3836.4, the mining intrinsically safe electrical apparatus shall also comply with the regulation of the standard GB 3836.1.

#### 5.2.15 Complex Electrical Apparatus

If you take more than one complex electrical apparatus, it is necessary to mark the main explosion-proof type before other explosion-proof types. For the marking method, refer to Appendix B of the standard GB 3836.1.

In addition to comply with the dedicated standard of corresponding explosion-proof type respectively, the complex electrical apparatus shall also comply with the regulation of GB 3836.1.

5.2.16 It is necessary to provide the electrical schematics or the wiring diagram sign usually in the enclosure of the electrical apparatus, and the graphic symbol and wiring number indicated in the figure shall comply with the regulation of relevant standard, such as GB/T 4026, GB/T 4728, GB/T 5094 and GB/T 7159.

5.2.17 The color of conductors within the electrical apparatus shall comply with the regulation of GB 2681, and the conductor of the intrinsically safe circuit shall be blue.

5.2.18 The color of the indication light and the button in the electrical apparatus shall comply with the regulation of GB/T 2682.

5.2.19 The enclosure of the electrical apparatus is usually identified by the color operating voltage of this electrical apparatus. It is red if it is greater than or equal to 6kV, yellow for 1.14 kV, gray for 0.66 kV and blue for 0.38 kV.

If this electrical apparatus is two general voltage equipments, the high voltage shall prevail.

### 5.3 Electrical Performance Requirements

#### 5.3.1 Action (Operation Condition)

The action (operation) condition in GB /T 14048.1 is applicable. Furthermore, it is supplementary specified as follows:

The control electrical apparatus such as the starter and contactor shall be closed reliably when the control supply voltage is 75% - 110% of the rated value (Us) with the ambient air temperature – 5 - 40°C when it takes the solenoid operation. At this time, the value 75% indicates the lower limit value of the pull operation voltage, while the value 110% shall be taken as the upper limit value. This action range is applicable for the AC and DC.

The release voltage for the solenoid operation shall not be higher than 60% of the rated control supply voltage (Us). For the AC frequency, its release voltage shall not be lower than 20% of Us. For the DC frequency, it shall not be lower than 10% of Us.

For the locking electrical apparatus, the pull action limit value shall be negotiated by the supplier and the purchaser.

For the shunt release, under-voltage release and over-current release of the high and low voltage power distribution apparatus, in addition to comply with the action range of the under-voltage relay and release, the action range of the shunt release, the action range of the current action relay and release in accordance with GB/T 14048.1 and the regulation of the closing operation and the release operation in accordance with GB 1984, it is supplementary specified as follows.

Taking the coal mine motor into account, the action range and time of the overload protection for the starter is shown in Table 7:

The operation condition of the high and low voltage power distribution device shall comply with the operation condition in GB/T 14048.2, the operation mechanism in GB 1984 and the operation mechanism clauses in GB 1985.

Table 7 Overload Protection Characteristics of Starter

| Serial No. | Setting Overload Current Ratio | Action Time   | Start Status |
|------------|--------------------------------|---|--------------|
| 1          | 1.05                           | > 2h  | Cold         |
| 2          | 1.2                            | < 20 min  | Hot          |
| 3          | 1.5                            | < 3 min   | Hot          |
| 4          | 6                              | Return Time $\geq$ 3 s<br>Return Time $\geq$ 5 s<br>Return Time $\geq$ 8 s<br>Return Time $\geq$ 15 s | Cold         |

Note:

1. The Return Time refers to this electrical apparatus shall not operate for a long time after the current is reduced to the setting current value of the electrical apparatus within the specified time when it passes through the over-current with the specified ratio.
2. The Return Time may be specified by the product standard of the light load, load, rather heavy load and heavy load for the use object of the electrical apparatus. It is usually recommended to be greater than or equal to 8s and 15 for the coal mine respectively.

### 5.3.2 Temperature Rise

For the low voltage and high voltage starter and the high and low voltage contactor, the terminal temperature rise and accessible parts temperature rise of the low voltage feed switch, and the temperature rise of the conductive parts, such as the main circuit and the control circuit, shall comply with GB/T 14048.1, GB/T 14048.2 and GB/T 14048.4.

For the heating (temperature rise) of relevant parts for the high voltage power distribution device, in addition to comply with above applicable heating clause in GB 1984 and GB 1985, the supplementary

regulation on the temperature rise of the coil for the low voltage starter light and the winding of the electromagnet shall comply with Table 8.

Table 8 Temperature Rise Limit of Insulated Coil (in Air)

| Insulation Material Level   | Temperature Rise Limit Measured by Resistance Method |
|---|--|
| A   | 65   |
| E   | 80   |
| B   | 90   |
| F   | 115  |
| H   | 140  |
| Note:<br>1. The temperature rise limit of the coil is specified based on the ambient temperature 40°C. For the use condition that the ambient temperature is lower than 40°C, the temperature rise limit in the table above may be adjusted correspondingly within the allowed operating temperature range of all insulation materials.<br>2. The working system specified in the table above is uninterrupted working system and the 8h working system. For the temperature rise of the winding in the intermittent periodic working system, it shall comply with the operation condition of the winding in the intermittent periodic working system in GB/T 14048.4, and the temperature rise still complies with the regulation in Table 8. Of which, the power-on time of the coil is selected by the load factor, and it is recommended to take the 15%, 25%, 40% and 60% level by the regulation of the product standard. |  |

### 5.3.3 Dielectric Properties

#### 5.3.3.1 Rated Impulse Withstand Voltage

The rated impulse withstand voltage of the low voltage electrical apparatus shall comply with the dielectric properties clause in GB/T 14048.1.

The rated impulse withstand voltage (lightning impulse withstand voltage) of the high voltage electrical apparatus and the auxiliary device shall comply with the regulation in Table 9.

Table 9 Standard Lightning Impulse Full Wave (Peak)

| Rated Voltage   | Between Ground, Inter-phase and Circuit Breaker Port |    | Between Isolation Switch Ports |    |
|---|--|----|--------------------------------|----|
|   | I  | II | I                              | II |
| 3.3   |  | 40 | 40                             | 50 |
| 6.0   | 40   | 60 | 46                             | 70 |
| 10.0  | 60   | 75 | 70                             | 85 |
| Note: The choice in column I and II shall comply with the insulation level section in GB 311.1. |  |    |                                |    |

#### 5.3.3.2 Power Frequency Withstand Voltage

In addition to the dielectric properties specified in GB/T 14048.1 and insulation level specified in GB 311, it is supplementary specified in Table 10 and 11.

Table 10 Power Frequency Withstand Voltage Test Value

| Rated Insulated Voltage ( $U_i$ ) | Power Frequency Withstand Voltage Test Value (AC RMS) |
|-----------------------------------|---|
| $U_i \leq 60$                     | 1,000   |
| $60 < U_i \leq 310$               | 2,000   |
| $300 < U_i \leq 660$              | 2,500   |

|  |       |
|--|-------|
| $660 < U_i \leq 800$   | 3,000 |
| $800 \leq U_i \leq 1,000$  | 4,200 |
| $1,200 \leq U_i \leq 16,500$ (DC limited only)   | 4,200 |
| Note: The power frequency withstand voltage at the rated operating voltage level 660V is classified into the rated insulated voltage level $660 \leq U_i \leq 800$ . |       |

Table 11 Power Frequency Withstand Voltage Test Value of High Voltage Electrical Apparatus

| Rated Voltage  | Insulated | 1 min Power Frequency Withstand Voltage (RMS)          |    |                                |    |                             |
|--|-----------|--|----|--------------------------------|----|-----------------------------|
|  |           | Between Ground, Inter-phase, Circuit Breaker and Ports |    | Between Isolation Switch Ports |    | Secondary Circuit to Ground |
|  |           | I  | II | I                              | II |                             |
| 3.3  | -         | 18   | 18 | 20                             | 2  |                             |
| 6.0  | 20        | 23   | 23 | 26                             | 2  |                             |
| 10.0   | 28        | 30   | 32 | 34                             | 2  |                             |
| Note:  |           |  |    |                                |    |                             |
| 1. The choice of the column I and II shall comply with the insulation level section in GB 311.1. |           |  |    |                                |    |                             |
| 2. The rated insulation level of products shall be transited to the II series gradually.         |           |  |    |                                |    |                             |

For the verification of the dielectric properties after the electrical property test (such as the on/off test and the short circuit test) of the low voltage electrical apparatus, the lowest power frequency withstand voltage is  $2U_i$  (but it is no less than 1,000Vac (RMS)), and it may require or specify the higher test voltage for relevant product standard. The recommended preferred value is  $2U_i+1,000V$  (AC RMS). However, the power frequency withstand voltage after the damp heat test shall refer to the similar standard of the electrical apparatus in the subtropical area. Furthermore, it will take the full voltage to verify the dielectric properties regardless of the high voltage or the low voltage.

The dielectric properties of the intrinsically safe electrical apparatus and the increased safety electrical apparatus shall comply with the regulation of the dielectric properties in GB 3836.4 and GB 3836.3.

### 5.3.3.3 Insulation Resistance

For the insulation resistance of the electrical apparatus, refer to Appendix A Insulation Resistance of Electrical Apparatus Used in Underground Mine.

5.3.4 Verify the switch-on, bearing and current breaking capacity under the no-load, normal load and overload condition.

#### 5.3.4.1 Rated Switch-on and Breaking Capacity

For the contactor and the starter type control electrical apparatus, in addition to the regulation of the switch-on and breaking capacity in GB/T 14048.4, it is supplementary specified as follows:

Different use types of the switch-on and breaking capacity of the contactor and starter type control electrical apparatus are specified by Table 12 regardless of the high voltage or the low voltage.

Table 12 Different Use Types of Switch-on and Shunting Condition

| Use Type | Rated Operating Current (A) | Switch-on Condition |         |            | On/Off Condition |         |            | On/Off Time (s) | Time Interval (s) | Times of Operations |
|----------|-----------------------------|---------------------|---------|------------|------------------|---------|------------|-----------------|-------------------|---------------------|
|          |                             | $I/I_e$             | $U/U_e$ | $\cos\Phi$ | $I/I_e$          | $U/U_e$ | $\cos\Phi$ |                 |                   |                     |
| AC-3     | $I_e \leq 100$              | 10                  | 1.1     | 0.35       | 8                | 1.1     | 0.35       | 0.05            | 2                 | 50                  |
|          | $I_e > 100$                 | 8                   | 1.1     | 0.35       | 6                | 1.1     | 0.35       | 0.05            | 2                 | 50                  |

|      |                |    |     |      |    |     |      |      |   |    |
|------|----------------|----|-----|------|----|-----|------|------|---|----|
| AC-4 | $I_e \leq 100$ | 12 | 1.1 | 0.35 | 10 | 1.1 | 0.35 | 0.05 | 2 | 50 |
|      | $I_e > 100$    | 10 | 1.1 | 0.35 | 8  | 1.1 | 0.35 | 0.05 | 2 | 50 |

Note:

- 0.05s listed in the table is the minimum, and the maximum switch-on time shall not exceed 0.2s. If the contact is closed completely before it is disconnected again, the allowed time is less than 0.05s. In this way, the maximum switch-on time may delay if it is agreed between users and manufacturers.
- In the time interval in GB/T 14048.4, the relationship between the switch-on capacity and the time interval is applicable. The time interval may be shortened if it is agreed by manufacturers.
- The allowed error of  $U/U_e$  is  $\pm 5\%$ .
- The switch-on shall be verified. The switch-on and the on/off capacity may be carried out at the same time if it is agreed by manufacturers. The operation cycles are 50. Of which, 25 operation cycles are 110%  $U_s$ , and 25 operation cycles are 75%  $U_s$ .

For the mining electrical apparatus switches of other use types not mentioned in this standard, it may comply with GB/T 14048.1 and applicable clauses of relevant product standard and the industry standard.

5.3.4.2 For the isolation switch for the starter, the rated breaking capacity of the isolation commutation switch is required.

In addition to comply with the applicable clauses of the breaking capacity in GB/T 14048.3 for the isolation electrical apparatus of the starter, it is supplementary specified in Table 13:

Table 13 Condition to Verify Rated Breaking Capacity

| Use Type | Rated Operation Current | Breaking Condition |           |                     | Times of Operation Cycles (Forward and Reverse) |
|----------|-------------------------|--------------------|-----------|---------------------|---|
|          |                         | $I_c/I_e$          | $U_r/U_e$ | $\cos\Phi \pm 0.05$ |   |
| AC-20B   | All currents            | 1                  | 1         | 0.35                | 3   |
| AC-22B   | All currents            | 3                  | 1         | 0.35                | 3   |
| AC-23B   | All currents            | 6                  | 1         | 0.35                | 3   |
|          |                         | 8                  | 1         | 0.35                | 3   |

Note:

- The  $I_r$  breaking capacity of the use type AC-20B is low, so it shall be eliminated gradually.
- The use type AC-22B shall usually meet the 3 $I_e$  breaking condition. It is recommended to take the breaking condition AC-23B 6 $I_e$  (or 8 $I_e$ ) preferred.

The requirement for the leakage current of the isolated electrical apparatus is under consideration.

#### 5.3.4.3 Frequently On/Off Capacity

The mining contactor and starter type control electrical apparatus shall be provided with the frequently on/off capacity requirement, and the on/off time interval (short-time operation frequency) is as follows: 1,800 times/hr, operation cycles are 10. Other on/off parameters shall comply with the requirement of the AC-4 electrical service life.

#### 5.3.4.4 Switch-on and Breaking Capacity of Reverse Contactor and Reverse Starter

The switch-on and breaking capacity of the reverse contactor and the reverse starter shall comply with the on/off current under the AC-4 condition specified in Table 12 Rated On/Off Capacity of this standard.

10 times of the operation cycles include the alternating on/off of two contactors:

Namely, A – B and B - A.

5.3.4.5 The switch-on and breaking capacity of the two-speed starter is the same as the common starter, and

the product shall provide the automatic or manual switching device from the low speed to the high speed. The switching may take the time principle and the current principle.

#### 5.3.4.6 Over-current Withstand Capacity

For the contactor with the use type AC-3 and AC-4, the over-current withstand capacity in GB/T 14048.4 Over-current Withstand Capacity of Starter is applicable.

#### 5.3.4.7 Specified Operation Performance

For the low voltage switching electrical apparatus, the specified operation performance in GB/T 14048.1 is applicable.

For the high voltage switching electrical apparatus, the mechanical operation performance in GB 1984, GB 1985, GB/T 11022, ZBK 35006 and GB/T 3309 is applicable. Furthermore, it is supplementary specified as follows:

For the operation control power voltage of the specified operation performance for the contactor and starter type electrical apparatus, it shall comply with the regulation of the operation condition in this standard. For the switch-on and breaking condition for the operation of different use types, the specified operation performance in GB/T 14048.4 is applicable.

#### 5.3.4.8 Mechanical Service Life (Mechanical Durability)

For the mechanical service life of the low voltage switching electrical apparatus, the mechanical service life in GB/T 14048.1, GB/T 14048.2, GB/T 14048.3 and GB/T 14048.4 is applicable. The test times of the mechanical service life are recommended as follows:

0.1, 0.3, 1, 3, 6, 10, 30 and 100(ten thousand times)

The concrete test times are specified by the classified standard and the industry standard of the product standard.

For the mechanical service life of the high voltage switching electrical apparatus, the mechanical service life in GB 1984, GB 1985, GB/T 11022, GB/T 3309 and ZBK 35006 is applicable.

#### 5.3.4.9 Electrical Service Life (Electrical Durability)

For the electrical service life of the low voltage switching electrical apparatus, the electrical service life in GB/T 14048.1, GB/T 14048.2 and GB/T 14048.4 is applicable. The concrete requirement is specified in the product standard.

For the electrical service life of the high voltage switching electrical apparatus, it is specified by relevant product type standard.

For the starter composed of contactors and the combined electrical apparatus, it is not necessary to test the electrical service life again for the mining electrical apparatus compose of this contactor if the electrical service life test for this contactor is carried out in the similar starter and combined electrical apparatus and the test report is within its validity period.

#### 5.3.4.10 Requirement for Auxiliary Contactor in Combined Electrical Apparatus and Starter

For the on/off condition, service life and other relevant characteristic requirement of the auxiliary contactor in the mining high and low voltage electrical apparatus, it is not necessary to test the mining electrical apparatus as long as the auxiliary contactor element complies with the requirement of respective standards, and corresponding equivalent test is passed, or the specified operation performance test in the combined electrical apparatus are carried out at random, and the test report is within its validity period.



### 5.3.5 Switch-on, Bearing and Short-circuit Current Breaking Capacity

#### 5.3.5.1 Coordination with Short-circuit Protection Electrical Apparatus

For the contactor, starter and combined electrical apparatus, in addition to the applicable clause of the coordination in GB/T 14048.1 and GB/T 14048.4, it is supplementary specified as follows:

##### 5.3.5.1.1 Performance under Short-circuit Condition (Rated Limit Short-circuit Current)

Table 14 Expected Test Current Corresponding to Rated Operating Current “r”<sup>1)</sup>

| Rated Operating Current (AC-3) (A) | Expected Test Current “r” (kA) |
|------------------------------------|--------------------------------|
| $I_e \leq 16$                      | 0.6                            |
| $16 < I_e \leq 63$                 | 1.5                            |
| $63 < I_e \leq 125$                | 2.5                            |

1) For the meaning of the current r and q, refer to GB/T 14048.1 and GB/T 14048.4.

Table 14 (End)

| Rated Operating Current (AC-3) (A) | Expected Test Current “r” (kA)             |
|------------------------------------|--|
| $125 < I_e \leq 200$               | 3.0  |
| $200 < I_e \leq 400$               | 4.5  |
| $400 < I_e \leq 630$               | 6.0  |
| $630 < I_e$                        | Negotiated between users and manufacturers |

Note:

- The test current r and the expected short-circuit current  $q^{1)}$  at the test point shall not be less than the maximum expected short-circuit current of relevant protection type, and the q current test may be carried out only when the current q is greater than the current “r”.
- “r” shown in Table 14 is the minimum expected test current. It may be raised to 1.5 times of the expected current for the test if it is required by manufacturers or users (equivalent to the specification in GB/T 14048.4).

##### 5.3.5.1.2 Selection between Overload Relay and SCPD

The selection between the overload relay and SCPD in GB/T 14048.4 is applicable.

##### 5.3.5.1.3 Limit Breaking Capacity of Mining Contactor and Starter

For the mining contactor, starter and combined electrical apparatus shall provide the limit (short-circuit) breaking capacity, the limit breaking current shall comply with the regulation in Table 15.

Table 15 Limit Breaking Current of Contactor and Starter

| Rated Operating Current (A) | Limit Breaking Current (kA) | $U_r/U_e$ | $\cos\Phi$      | Switch-on Time (s) | Time Interval (s) | Number of Tests |
|-----------------------------|-----------------------------|-----------|-----------------|--------------------|-------------------|-----------------|
| $I_e \leq 16$               | 0.6                         | 1         | $0.65 \pm 0.05$ | 0.05~0.2           | 180               | 3               |
| $16 < I_e \leq 16$          | 1.5                         |           |                 |                    |                   |                 |
| $63 < I_e \leq 80$          | 2.0                         |           |                 |                    |                   |                 |
| $80 < I_e \leq 125$         | 2.5                         |           |                 |                    |                   |                 |
| $125 < I_e \leq 200$        | 3.0                         |           |                 |                    |                   |                 |
| $200 < I_e \leq 250$        | 4.5                         |           |                 |                    |                   |                 |
| $250 < I_e \leq 400$        | 4.5                         |           |                 |                    |                   |                 |
| $400 < I_e \leq 630$        | 6.0                         |           |                 |                    |                   |                 |

Note:

1.  $I_e > 630$  is determined by negotiating between users and manufacturers.
2. The switch-on time is allowed to delay if it is agreed by manufacturers.
3. The limit (short-circuit) breaking capacity of the contactor and the starter is closely associated with SCPD. The manufacturers shall take proper SCPD if the expected short-circuit is greater than the limit breaking capacity at the installation point. For the coordination of the short-circuit protection electrical apparatus, it usually takes the fuse as SCPD for the main coordinated short-circuit protection.

### 5.3.5.3 Short-circuit Performance of Low Voltage Power Distribution Electrical Apparatus (Feed Switch)

For the short-circuit performance of the power distribution electrical apparatus, such as the low voltage electrical apparatus, the short-circuit and breaking capacity in GB/T 14048.2 is applicable. The concrete content is specified by the product standard.

### 5.3.5.4 Short-circuit Performance of High Voltage Power Distribution Electrical Apparatus

For the short-circuit performance of the high voltage contactor and the high voltage electrical apparatus, it shall comply with relevant clauses in GB 1984, GB 1985, GB/T 11022 and ZBK 35006. The concrete content is specified by the product standard definitely.

### 5.3.6 On/Off Operation Over-voltage

The GB /T 14048.1 On/Off Operation Over-voltage is applicable, and it is supplemented as follows:

For the operation over-voltage of the high and low voltage switching electrical apparatus, especially for the vacuum switching electrical apparatus, manufacturers shall provide users with the test data of the cutoff value ( $I_0$ ) for the vacuum switching electrical apparatus connector used or the demonstrated data of the over-voltage absorption device.

In general, the operation over-voltage of the low voltage electrical apparatus shall not exceed 2 times, and the operation over-voltage of the high voltage electrical apparatus shall not exceed 2.8 times. It may also commission the QC institute to test the over-voltage ratio by negotiating between users and manufacturers.

### 5.3.7 Protection

The starter and the combined electrical apparatus shall be provided with the short-circuit, overload, loss of phase and under-voltage protection. Furthermore, it shall be provided with the current leakage locking and remote control device in accordance with the standard.

The low voltage feed switch wire used in the underground mine shall mount the leakage detection and protection device with the current leakage locking or the selective leakage detection and protection device. If there is not this device, it is necessary to mount the leakage detection device to cut off the current leakage feed line automatically.

The high voltage feed line of the central substation used in the underground mine shall mount the selective single-phase grounding protection device. The high voltage feed line of the mobile substation shall mount the selective acted on the tripped single-phase grounding protection device.

The integrated protection device of the coal drill shall be provided with the leakage detection, short-circuit, overload and remote control device. Furthermore, it shall be also provided with the loss of phase protection device.

In addition to above protection, the mining high and low voltage switching electrical apparatus and its combination may be provided with the gas leakage, temperature, over-voltage, insulation monitoring, liquid level and self-test circuit protection in accordance with the characteristics of products themselves and the operating object.

For the specification of basic parameters for the leakage detection relay, refer to Table 16.

Table 16 Basic Parameters of Leakage Detection Relay

| Compensation Type | Rated Voltage (V) | Resistant Setting Value of Single-phase Current Leakage Action ( $k\Omega+20\%$ ) | Resistant Setting Value of Single-phase Current Leakage Locking ( $k\Omega+20\%$ ) | Action Time at $1k\Omega$ Resistance (ms) | Capacitance $0.22 - 1.0\mu f/Phase$ Compensation Rate (%) |
|-------------------|-------------------|---|--|---|---|
| Yes               | 1140              | 20  | 40   | $\leq 50$                                 | $>60$   |
|                   | 660               | 11  | 22   | $\leq 80$                                 |   |
|                   | 380               | 3.5   | 7.0  |   |   |
| No                | 1140              | 20  | 40   | $\leq 30$                                 | -   |
|                   | 660               | 11  | 22   |   |   |
|                   | 380               | 3.5   | 7.0  |   |   |
|                   | 127               | 3.0   | 6.0  | $\leq 250$                                |   |

Note:

- For the product with the current leakage action only.
- For the 127V integrated protection device of the coal drill, the single-phase current leakage action and setting value may be adjusted between  $1.5 - 3k\Omega$  by manufacturers. It is recommended to take  $3k\Omega$  and shall be adjusted to be  $3k\Omega$  during the shipment. The current leakage locking value shall not be lower than this standard value, and 250ms refers to the full breaking action time.

The action parameters of the leakage detection (grounding protection) device for the high voltage power distribution device are specified as follows<sup>2)</sup>:

Lowest starting current:  $I_0=0.5A^{3)4)}$ , Maximum setting current:  $I_0=6A$

Lowest starting voltage:  $U_0=3V^{3)4)}$ , Maximum setting voltage:  $U_0=25V$

- Users and manufacturers shall negotiate to determine which protection is set on demand. In addition to the regulation of GB/T 14048.4 and this standard, the concrete technical parameters of above protection are specified by the product standard.
- It shall take above parameters regardless of the power direction type, current type or current direction type protection principle.
- $I_0$  is the primary current of the zero sequence current transformer, and  $U_0$  is the opening voltage of the open delta for the zero sequence transformer.
- In order to ensure the current leakage resistance acts reliably under the resistance  $1k\Omega$ , it is recommended that the action value will not exceed 10V. It is recommended that the maximum setting current  $I_0$  will not exceed 2A, to improve the sensitivity of the current leakage protection device.

The action time of the protection device itself shall be less than or equal to 100ms.

### 5.3.8 EMI Immunity Requirements for Electronic and Electrical Appliances

Unless otherwise specified in the product standard, the EMI immunity requirements for the electronic and electrical appliances in GB/T 14048.1 EMI Immunity Requirements for Electronic Appliances are applicable.

### 5.3.9 Resistance to Low Temperature (High Temperature) Performance

For the component, plug-in, and element with the temperature sensitivity, such as the electronic appliance, it is necessary to carry out the high temperature and the low temperature test to verify its adaptability.

## 6 Test Method

### 6.1 Verification Structure and Requirement for Explosion-proof Performance

It is specified in Table 17:

Table 17 Specification Schedule for Test Method of Structure and Explosion-proof Performance

| Serial No. | Test Item                                | Standard and Clause Met  |
|------------|--|--|
| 1          | Material Test                            |  |
| 1.1        | Mining Ordinary Electrical Apparatus     | GB/T 12173 Material  |
| 1.2        | Explosion-proof                          | GB 3836.1 Plastic enclosure, light alloy enclosure                         |
| 1.3        | Flame-proof                              | GB 3836.2 Flame-proof enclosure material                                   |
| 2          | Mechanical Test of Enclosure             |  |
| 2.1        | Mining Ordinary Electrical Apparatus     | GB/T 12173 Strength  |
| 2.2        | Explosion-proof                          | GB 3836.1 Mechanical Test  |
| 3          | Protection Test of Enclosure             | GB 3836.1 Protection Performance Test of Enclosure                         |
| 3.1        | Mining Ordinary Electrical Apparatus     | GB/T 12173 Degree of Protection  |
| 3.2        | Increased Safety                         | GB 3836.3 Degree of Protection for Enclosure                               |
| 3.3        | Intrinsically Safe <sup>1)</sup>         | GB 3836.4 Enclosure  |
| 4          | Fastening of Enclosure and Fastener Test |  |
| 4.1        | Mining Ordinary Electrical Apparatus     | GB/T 12173 Fasteners   |
| 4.2        | Explosion-proof                          | GB 3836.1 Fasteners  |
| 4.3        | Flame-proof                              | GB 3836.2 Fasteners of Enclosure   |
| 5          | Marking, Interlocking and Warning Sign   |  |
| 5.1        | Mining Ordinary Electrical Apparatus     | GB/T 12173 Marking Nameplate and Interlocking                              |
| 5.2        | Explosion-proof                          | GB 3836.1 Overview and Interlocking Device, Switch and Controller, Marking |
| 5.3        | Flame-proof <sup>1)</sup>                | GB 3836.2 Interlocking and Warning Sign                                    |
| 5.4        | Intrinsically Safe <sup>1)</sup>         | GB 3836.4 Nameplate and Marking  |
| 5.5        | Complex <sup>1)</sup>                    | GB 3836.1 Appendix B   |
| 6          | Test of Cable Entry                      |  |
| 6.1        | Mining Ordinary Electrical Apparatus     | GB/T 12173 Cable Entry   |
| 6.2        | Explosion-proof                          | GB 3836.1 Clamping Test of Cable and Wire Entry                            |
| 6.3        | Flame-proof                              | GB 3836.2 Entry Test   |
| 7          | Clearance and Creepage Distance          | GB 3836.3 Clearance and Creepage Distance                                  |
| 8          | Grounding                                | GB 3836.1 Grounding  |

Table 17 (End)

| Serial No. | Test Item                            | Standard and Clause Met               |
|------------|--------------------------------------|---------------------------------------|
| 9          | Damp Heat Test                       |                                       |
| 9.1        | Mining Ordinary Electrical Apparatus | GB/T 12173 Resistant to Moisture Test |
| 9.2        | Explosion-proof                      | GB 3836.1 Damp Heat Test              |
| 10         | Temperature                          |                                       |
| 10.1       | Mining Ordinary Electrical Apparatus | GB/T 12173 Surface Temperature        |
| 10.2       | Explosion-proof                      | GB 3836.1 Temperature                 |

|  |                                  |  |
|--|----------------------------------|--|
| 10.3   | Increased Safety <sup>1)</sup>   | GB 3836.3 Limit Temperature  |
| 10.4   | Intrinsically Safe <sup>1)</sup> | GB 3836.4 Temperature Test   |
| 11   | Torque Test of Connecting Part   |  |
| 11.1   | Explosion-proof                  | GB 3836.1 Torque Test of Connecting Part                             |
| 12   | Explosion-proof Test             | GB 3836.1 Various Tests of Electrical Apparatus in Explosive Mixture |
| 1) Special requirement other than the explosion-proof-met requirement. |                                  |  |

## 6.2 Verification of Electrical Performance Requirements

Various test methods of the mining electrical apparatus is specified as shown in Table 18.

Table 18 Specification Schedule of Test Method for Electrical Performance Verification

| Serial No. | Test Item   | Standard and Clause Met  |
|------------|---|--|
| 1          | Action (operation condition) characteristics, electromagnetic operating characteristics and tripping characteristics  | GB/T 14048.1 Verify Action Range<br>GB/T 14048.4 Action Range<br>GB/T 14048.2 Tripping Action Range<br>GB/T 3309 Operation Characteristics   |
| 2          | Temperature Rise (Heat) Test  | GB/T 14048.2 and GB/T 14048.4 Temperature Rise Test<br>GB/T 763 and GB 1984 Heating Test   |
| 3          | Dielectric Properties<br>Voltage Impulse Withstand Test<br>Power Frequency Voltage Withstand Test   | GB/T 14048.1, GB/T 14048.2, GB/T 14048.3 and GB/T 14048.4 Dielectric Properties Test<br>GB 311 Insulation Requirement<br>GB 3836.4 and GB 3836.2 Requirement for Power Frequency Voltage Withstand Test  |
| 4          | Switch-on, Bearing and Breaking Current Capacity under No-load, Normal Load and Overload Condition<br>Rated Switch-on and Breaking Capacity<br>Frequently On/Off Capacity Test<br>Over-current Withstand Capacity Test<br>Reversible Conversion Capacity Test<br>Electrical Life Test<br>Specified Operation Performance Test | GB/T 14048.1 – 4 Switch-on and Breaking Capacity<br>GB/T 14048.4 Switch-on and Breaking Capacity<br>GB/T 14048.4 Over-current Withstand Capacity<br>GB/T 14048.4 Reversible Conversion Test<br>GB/T 14048.4 Electrical Life Test<br>GB/T 14048.2 Electrical Life Test<br>GB/T 14048.1 and GB/T 14048.2 – 4 No-load Operation and Load Operation Test |

Table 18(End)

| Serial No. | Test Item   | Standard and Clause Met  |
|------------|---|--|
| 5          | Performance under Short-circuit Condition<br>Short-circuit Switch-on and Breaking Capacity Test<br>SCPD Coordination Test<br>Short-circuit Closing and Opening Test<br>Short-time Current Withstand Test<br>Limit Breaking Capacity | GB/T 14048.1 – 4 Short-circuit Switch-on and Breaking Capacity<br>GB/T 14048.1 and GB/T 14048.4 Test and SCPD Coordination Test<br>GB 1984, GB 1985 and GB/T 2706 Short-circuit Opening and Closing Test<br>GB 1984, GB 1985, GB/T 2706 and GB/T 14048.2 Short-circuit Current Withstand Test and Dynamic Stability Test |

|    |   |  |
|----|---|--|
| 6  | On/Off Operation Over-voltage                         | GB/T 14048.4 Operation Over-voltage Test   |
| 7  | Protection Test                                       | GB/T 998, GB/T 14048.4, MT 175, MT 189 and ZBK 35066 Protection Performance Test |
| 8  | EMI Immunity Test of Electrical Apparatus             | GB/T 14048.1 EMI Immunity Test   |
| 9  | Low Temperature (and High Temperature) Withstand Test | MT 209 High and Low Temperature Test   |
| 10 | Impact and Vibration Test                             | It is specified by relevant product standard.                                    |

## 7 Inspection Rules

### 7.1 Inspection Classification

The inspection of the electrical apparatus is divided into two types:

- a) Type test
- b) Factory inspection

7.1.1 The type test shall be carried out under one of the following conditions:

- a) The sample identification test of new products or original products transfers to other plants for the production.
- b) If it may have an effect on the product performance for the obvious change of the structure, material and process after the normal production.
- c) The periodic test shall be carried out during the normal production.
- d) The production is restored after the shutdown of products.
- e) When the national quality supervision institution puts forward the requirement.

For the standard clause of corresponding regulation cited for the type test item and various tests, refer to the regulation of Table B1 in Appendix B and Table C1 in Appendix C of this standard.

The electrical apparatus shall determine the test item or the test sequence in the enterprise standard of products in accordance with the characteristics and the regulation of this standard and relevant product standard. Unless otherwise specified, the quantity of test samples for each test (or each groups of sequence) shall not be less than 2.

#### 7.1.2 Factory Inspection

The factory inspection is to inspect the material defect and the manufacturing defect of the products, and is of the inspection and test project that manufacturers shall carry out one by one before the shipment.

For the standard clause of corresponding regulation cited for the factory inspection and test project and various tests, refer to the regulation of Table B1 in Appendix B and Table C1 in Appendix of this standard.

### 7.2 Inspection Rules

#### 7.2.1 Inspection Rules of Type Test

The electrical apparatus for the type test shall be the formal test sample whose structure, manufacturing and material complies with the design requirement. The type test of this electrical apparatus may be considered as qualified only when all test items (or sequence) of the type test can pass and all samples for the test are qualified. Otherwise, it is necessary to analyze the cause, and take corresponding measures, or even improve the design, process and tools for the test again, until the type test is qualified.

If there is some defect of the sample for the type test that doesn't endanger the safety or doesn't reduce the

key performance, and manufacturers provide enough evidence to demonstrate that the defect is not inherent in the design, but in individual sample, it is allowed to be retested. The product standard shall specify the test items, quantity and qualified criteria to be retested.

### 7.2.2 Factory Inspection Rules

The factory inspection items shall be carried out on each factory product one by one, and the unqualified product shall be reworked one by one until it is qualified completely. It shall be scrapped if it can not be repaired.

## 8 Marking, Packaging, Transportation and Storage

### 8.1 Marking

In addition to comply with the regulation of GB 3836.1 Marking section, the electrical apparatus with various explosion-proof types shall also comply with the regulation of the nameplate, marking section and clause in the dedicated explosion-proof standard itself. Furthermore, it shall be supplementary specified as follows:

Necessary Marking: Explosion-proof type, safety marking, product model, voltage rating and explosion-proof certificate number. Required Marking: Key technical parameters and product standard number.

### 8.2 Packaging

The packaging of the electrical apparatus shall prevent from damage during the transportation. Furthermore, it shall meet the requirement for the rainproof. It shall include the packing list, product certificate, use and maintenance manual of products in the packaging.

The packaging marking of the enclosure for the electrical apparatus shall be clear and orderly, to ensure it is not burr for the transportation and storage. The content includes as follows:

- a) Manufacturer's name or trademark
- b) Product name and model
- c) Dimension (L\*W\*H) and gross weight of the packing list
- d) Name and address of the receiving unit
- e) Mark that the storage and transportation marking shall comply with the regulation of GB 191, such as handle with care, keep dry and upward. Other requirement of the packaging shall also comply with the regulation of GB/T 1388.

8.3 The transportation and storage condition shall comply with the regulation of GB/T 14048.1 Transportation and Storage Condition, and comply with the following regulation:

8.3.1 The electrical apparatus shall be place in the warehouse without rain and snow ingress, air ventilation, relative humidity not greater than 95% (25°C) and temperature no high than 40°C and no lower than -5°C. The free fall height is 100 mm (when the weight of the package is no more than 100 kg), the supplier and purchaser shall negotiate with each other by taking the low temperature for the transportation may be lower than -5°C - 25°C.

8.3.2 Transportation and Storage Test: It shall comply with the regulation of GB/T 14048.1 Transportation and Storage Test. Furthermore, it is supplementary specified as follows: The low temperature (high temperature) and damp heat test is allowed to be replaced with corresponding test in the performance requirement.

**Appendix A**

(Normative Appendix)

**Insulation Resistance of Electrical Apparatus Used in Underground Mine**

For the insulation resistance of the electrical apparatus used in the underground mine, refer to Table A1.

Table A1

(MΩ)

| Condition  | Insulation Resistance Value |      |      |      |      |        |        |        |         |
|--|-----------------------------|------|------|------|------|--------|--------|--------|---------|
|  | ≤60V                        | 127V | 220V | 380V | 660V | 1,140V | 3,300V | 6,000V | 10,000V |
| Normal Temperature:20±5℃<br>Relative Humidity: 50% – 70% | ≥2                          | >20  | >20  | >20  | >50  | >100   | >500   | -      | -       |
| After Damp Heat Test                                     | 1                           | 1.5  | 1.5  | 1.5  | 2.0  | 2.5    | 4      | -      | -       |

Note:

1. The data under the normal temperature may be taken as the factory inspection data and will not be taken as the judgment criteria of the qualification during the type test.
2. The data after the damp heat test shall be taken as the judgment criteria of the qualification. 3,300V or higher will not be used for the examination of the insulation resistance, but used for the examination of the dielectric properties.
3. The insulation resistance of the electrical apparatus greater than 1,200V may be taken as the criteria to judge whether the insulation is in the good stats by referring to 1kΩ/V.
4. The choice of the MΩ shall comply with the regulation of GB/T 998.

**Appendix B**

(Normative Appendix)

**Test Items to be Carried Out for Electrical Apparatus Used in Underground Mine**

For the test items to be carried out for the electrical apparatus used in the underground mine, refer to Table B1.

Table B1

| Serial No. | Test Item Name   | Mining Ordinary | Flame-proof | Increased Safe | Intrinsically Safe | Remarks   |
|------------|--|-----------------|-------------|----------------|--------------------|---|
| 1          | Visual Inspection  | ☆               | ☆           | ☆              | ☆                  | -   |
| 2          | Temperature Rise   | ✓               | ✓           | ✓              | ✓                  | -   |
| 3          | Dielectric Properties  | ☆               | ☆           | ☆              | ☆                  | -   |
| 4          | Switch-on, Bearing and Current Breaking Capacity under No-load, Normal Load and Overload Condition | ✓               | ✓           | ✓              | -                  | -   |
| 5          | Switch-on, Bearing and Short-circuit Current Breaking Capacity                                     | ✓               | ✓           | ✓              | -                  | -   |
| 6          | Mechanical Life  | ✓               | ✓           | ✓              | -                  | -   |
| 7          | Electrical Life  | ✓               | ✓           | ✓              | -                  | -   |
| 8          | Damp Heat Resistance   | ✓               | ✓           | ✓              | ✓                  | -   |
| 9          | Impact   | ✓               | ✓           | ✓              | ✓                  | Limited to the regulation in article 21.1.1 in GB 3836.1. |

Table B1 (End)



| Serial No. | Test Item Name  | Mining Ordinary | Flame-proof | Increase d Safe | Intrinsically Safe | Remarks   |
|------------|---|-----------------|-------------|-----------------|--------------------|---|
| 10         | Drop Test   | ✓               | ✓           | ✓               | ✓                  | Convenience for portable electrical apparatus   |
| 11         | Protection Performance of Enclosure                             | ✓               | -           | ✓               | ✓                  | -   |
| 12         | Torque of Connecting Part                                       |                 | ✓           | ✓               |                    |   |
| 13         | Thermal Stability   |                 | ✓           | ✓               | -                  | Limited to the plastic enclosure or the enclosure part (other than the insulated sleeve) seal plastic liner |
| 14         | Hot Drastic Change  |                 | ✓           | ✓               |                    | Limited to light with transparent parts   |
| 15         | Measurement of Insulation Resistance for Plastic Enclosure      |                 | ✓           | ✓               | ✓                  | -   |
| 16         | Clamping of Cable and Wiring Entry                              | -               | ✓           | ✓               | -                  | -   |
| 17         | Sealing of Cable and Wiring Entry                               | -               | ✓           |                 | -                  | -   |
| 18         | Aging of Rubber Material  | ✓               | ✓           | ✓               | -                  | -   |
| 19         | Strength  | -               | ☆           | -               | -                  | The dynamic strength test shall be carried out by the national designated inspection unit.                  |
| 20         | Flame-proof Performance   | -               | ✓           | -               | ✓                  | The flame-proof performance test shall be carried out by the national designated inspection unit.           |
| 21         | Spark   |                 | -           | -               | -                  | The spark test shall be carried out by the national designated inspection unit.                             |
| 22         | Handle  | ✓               | -           |                 | -                  | -   |
| 23         | Protection Performance  | ✓               | ✓           | ✓               | ✓                  | -   |
| 24         | Vibration of Electrical Apparatus                               | ✓               | ✓           | ✓               | ✓                  | -   |
| 25         | High and Low Temperature (Storage Test) of Electrical Apparatus | ✓               | ✓           | ✓               | ✓                  | -   |
| 26         | High and Low Temperature  | ✓               | ✓           | ✓               | ✓                  | -   |

|   |   |  |  |  |  |  |
|---|---|--|--|--|--|--|
|   | (Operating Environment) of Electrical Apparatus |  |  |  |  |  |
| <p>Note:</p> <ol style="list-style-type: none"> <li>✓ indicates the items to be carried out for the type test.</li> <li>☆ indicates the items to be carried out for the type test and factory inspection.</li> <li>For the complicated items with huge test cost, it may negotiate with the national designated inspection unit for the periodic inspection during the normal production, such as the serial number 5 and 7.</li> </ol> |   |  |  |  |  |  |

## Appendix C

(Normative Appendix)

### Standard Clause of Corresponding Regulation Cited in Electrical Apparatus and Various Tests Used in Underground Mine

For the standard clause of the corresponding regulation cited in the electrical apparatus and various tests used in the underground mine, refer to Table C1.

Table C 1

| Serial No. | Test Item  | Cite Standard Clause of Corresponding Specification   |
|------------|--|---|
| 1          | Visual Inspection (including Action Requirement) | Corresponding regulation of respective product standards  |
| 2          | Temperature Rise                                 | The low voltage electrical apparatus shall comply with GB/T 14048.1 Temperature Rise, and the high voltage electrical apparatus shall comply with GB/T 763. |

Table C1 (End)

| Serial No. | Test Item  | Cite Standard Clause of Corresponding Specification   |
|------------|--|---|
| 3          | Dielectric Properties  | The low voltage electrical apparatus shall comply with GB/T 14048.1 Dielectric Properties, and the high voltage electrical apparatus shall comply with GB 311.  |
| 4          | Switch-on, Bearing and Current Breaking Capacity under No-load, Normal Load and Overload Condition | The low voltage electrical apparatus shall comply with GB/T 14048.1 Switch-on, Bearing and Current Breaking Capacity under No-load, Normal Load and Overload Condition.   |
| 5          | Switch-on, Bearing and Short-circuit Current Breaking Capacity                                     | The low voltage electrical apparatus shall comply with GB/T 14048.1 Switch-on, Bearing and Short-circuit Current Breaking Capacity, and the high voltage electrical apparatus shall comply with GB/T 2706.              |
| 6          | Mechanical Life  | The low voltage electrical apparatus shall comply with GB/T 14048.1 Mechanical Life (Mechanical Durability), and the high voltage electrical apparatus shall comply with the regulation of respective product standard. |
| 7          | Electrical Life  | The low voltage electrical apparatus shall comply with GB/T 14048.1 Electrical Life (Electrical Durability).  |
| 8          | Damp Heat Resistance   | GB 3836.1 Damp Heat Test  |
| 9          | Impact   | GB 3836.1 Impact Test   |
| 10         | Drop Test  | GB 3836.1 Drop Test   |
| 11         | Protection Performance of Enclosure  | GB/T 4942.2 or GB 4208  |
| 12         | Torque of Connecting Part  | GB 3836.1 Torque Test of Connecting Part  |
| 13         | Thermal Stability  | GB 3836.1 Thermal Stability Test  |
| 14         | Hot Drastic Change   | GB 3836.1 Hot Drastic Change Test   |
| 15         | Measurement of Insulation Resistance for Plastic Enclosure   | GB 3836.1 Measurement of Insulation Resistance for Plastic Enclosure  |

|    |  |   |
|----|--|---|
| 16 | Clamping of Cable and Wiring Entry                                       | GB 3836.1 Clamping Test of Cable and Wiring Entry   |
| 17 | Sealing of Cable and Wiring Entry  | GB 3836.1 Entry Test  |
| 18 | Aging of Rubber Material   | GB 3836.1 Aging Test of Rubber Material   |
| 19 | Strength   | GB 3836.2 Strength Test   |
| 20 | Flame-proof Performance  | GB 3836.2 Flame-proof Performance Test  |
| 21 | Spark  | GB 3836.4 Spark Test  |
| 22 | Temperature  | GB 3836.4 Temperature Test  |
| 23 | Handle   | GB 3836.4 Handle Test   |
| 24 | Protection Performance   | Comply with respective product standard.  |
| 25 | Vibration  | The low voltage electrical apparatus shall comply with GB/T 14048.1 Vibration and Impact Requirement for Electrical Apparatus.  |
| 26 | EMI Immunity of Electrical Apparatus                                     | The low voltage electrical apparatus shall comply with GB/T 14048.1 EMI Immunity of Electrical Apparatus, and the high voltage electrical apparatus shall comply with GB/T 11022 Wireless Interference. |
| 26 | High and Low Temperature (Operating Environment) of Electrical Apparatus | The low voltage electrical apparatus shall comply with GB/T 14048.1 Low Temperature (and High Temperature) Withstand Performance.   |