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General Requirements for Preventing Electrostatic

Accidents

防止静电事故通用要求

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General Requirements for Preventing Electrostatic Accidents

1 Scope

This document specifies the general requirements for electrostatic protection, electrostatic management measures, requirements for area of electrostatic hazards, electrostatic protection measures for solid, liquid, gaseous and powdery materials, human body electrostatic protection measures, as well as analysis and determination of electrostatic accidents to prevent combustion and explosion caused by electrostatic discharge.

This document is applicable to the design and management of area of electrostatic hazards.

NOTE: protection against other electrostatic hazards (for example, electrostatic shock) may take this as a reference.

This document does not apply to the prevention of electrostatic hazards of explosives and powders, electric initiating explosive devices, and fireworks.

2 Normative References

The contents of the following documents constitute indispensable clauses of this document through the normative references in the text. In terms of references with a specified date, only versions with a specified date are applicable to this document. In terms of references without a specified date, the latest version (including all the modifications) is applicable to this document.

GB/T 3684 Conveyor Belts - Electrical Conductivity - Specification and Test Method

GB/T 3836.26-2019 Explosive Atmospheres - Part 26: Electrostatic Hazards - Guidance

GB 6950 Safe Rest Conductivity of Light Fuel Oil

GB 8965.1 Protective Clothing - Flame Retardant Protective Clothing

GB/T 9572 Rubber and Plastics Hoses and Hose Assemblies - Determination of Electrical Resistance and Conductivity

GB 12014 Protective Clothing - Static Protective Clothing

GB/T 15463 Electrostatic Safety Terminology

GB 21148 Foot Protection - Safety Footwear

GB/T 22845 Anti-electrostatic Glove

GB 50058 Code for Design of Electrical Installations in Explosive Atmospheres

GB/T 50493 Standard for Design of Combustible Gas and Toxic Gas Detection and Alarm for Petrochemical Industry

3 Terms and Definitions

The terms and definitions defined in GB/T 15463 and GB 6951 and the following are applicable to this document.

3.1 static conductor

Under the conditions of use, the material with a volume resistivity less than or equal to $1 \times 10^6 \Omega \cdot \text{m}$ (i.e., the conductivity is greater than or equal to $1 \times 10^{-6} \text{ S/m}$) or the solid surface with a surface resistivity less than or equal to $1 \times 10^7 \Omega$.

NOTE: the volume resistivity and surface resistivity of various materials and surfaces need to be tested in the temperature and humidity environment specified by the standard test method. If the test conditions are optional, the conditions of use refer to the temperature and humidity conditions closest to the environment of use.

3.2 static sub-conductor

Under the conditions of use, the material with a volume resistivity greater than $1 \times 10^6 \Omega \cdot \text{m}$ and less than $1 \times 10^{10} \Omega \cdot \text{m}$ (i.e., the conductivity is greater than $1 \times 10^{-10} \text{ S/m}$ and less than $1 \times 10^{-6} \text{ S/m}$) or the solid surface with a surface resistivity greater than $1 \times 10^7 \Omega$ and less than $1 \times 10^{11} \Omega$.

NOTE: the volume resistivity and surface resistivity of various materials and surfaces need to be tested in the temperature and humidity environment specified by the standard test method. If the test conditions are optional, the conditions of use refer to the temperature and humidity conditions closest to the environment of use.

3.3 static non-conductor

Under the conditions of use, the material with a volume resistivity greater than or equal to $1 \times 10^{10} \Omega \cdot \text{m}$ (i.e., the conductivity is less than or equal to $1 \times 10^{-10} \text{ S/m}$) or the solid surface with a surface resistivity greater than or equal to $1 \times 10^{11} \Omega$.

NOTE: the volume resistivity and surface resistivity of various materials and surfaces need to be tested in the temperature and humidity environment specified by the standard test method. If the test conditions are optional, the conditions of use refer to the temperature and humidity conditions closest to the environment of use.

3.4 minimum ignition energy; MIE

Under normal temperature and pressure conditions, the minimum electrical energy required to

[source: GB 6951-1986, 1.1]

3.13 relaxation time of charge

The time required for the charge (or potential) on a charged body to dissipate to $1/e$ (about 37%) of its initial value.

3.14 relaxation chamber

A thick-diameter pipe section or relaxation storage tank installed in the pipeline system to slow down the flow of charged liquid flowing in the pipe, so that the charge can be thoroughly leaked and attenuated to a safe range.

3.15 time of response; time of rest

When producing in a place with electrostatic hazards exist, the interval time required from the equipment stopping operation to the static electricity carried by the material (usually liquid) dissipating to below the safe value, allowing the next operation to be carried out.

3.16 electrostatic discharge

The phenomenon that the electric field strength formed by a charged object exceeds the breakdown field strength of the surrounding medium, or contacts with other objects, causing the charge to dissipate or transfer.

3.17 electrostatic accident

An unexpected incident that causes casualties or property loss due to electrostatic discharge.

4 General Requirements

4.1 Discharge and Ignition

4.1.1 The workplace shall reduce the generation of high ignition capacity electrostatic discharge types, such as spark discharge and propagating brush discharge. Different discharge forms have different ignition capabilities. The characteristics of typical electrostatic discharges and their ignition capabilities are shown in Table 1.

Appendix A for the table of electrostatic electrification polarity sequence.

4.2.1.2 In the design of production process, the impact, friction and separation process shall be reduced by optimizing the process, and the contact area and pressure of the relevant materials shall be reduced, the number of contacts shall be reduced, and the movement and separation speed shall be reduced.

4.2.2 Accelerate electrostatic dissipation

4.2.2.1 In the area of electrostatic hazards, all static conductors insulated from the earth shall be earthed. Metal objects shall be in conductive connection with the earth through metal conductors. Static conductors and sub-conductors other than metals shall be indirectly earthed.

4.2.2.2 The anti-electrostatic earthing wire shall not utilize the neutral wire of the power supply, shall not be shared with the exclusive downlead for lightning protection, and shall not be connected to the earth in series.

4.2.2.3 The earthing resistance shall not be greater than $100\ \Omega$. The leakage resistance of the static conductor shall not be greater than $1.0 \times 10^6\ \Omega$, and the leakage resistance of the static sub-conductor shall not be greater than $1.0 \times 10^9\ \Omega$. When a leakage resistor is required to limit the discharge current of the static conductor to the earth, the leakage resistance shall be greater than $1.0 \times 10^4\ \Omega$.

4.2.2.4 When indirect earthing is performed, metal foil shall be added between the metal conductor and the non-metallic electrostatic conductor or electrostatic sub-conductor, or conductive paint or conductive agent shall be applied to reduce contact resistance.

4.2.2.5 Production process equipment shall adopt electrostatic conductors or electrostatic sub-conductors. The use of electrostatic non-conductors shall be confirmed by tests or normative documents for their safety. The test records or confirmation materials shall be included in the electrostatic protection management system.

4.2.2.6 If the process allows, the relative humidity of the local environment shall be increased to more than 50%, but humidification shall not be used in the 0 zone of explosive gas atmosphere.

4.2.2.7 For highly charged materials, the electrostatic risk shall be reduced by installing a relaxation chamber at an appropriate position near the discharge outlet, or by adding an appropriate amount of anti-electrostatic additives to certain materials to reduce their resistivity.

4.2.2.8 Operating tools made of electrostatic conductors at the production site shall be earthed.

4.2.3 Supplementary measures

4.2.3.1 The charged body shall be partially or completely shielded from static electricity, or various forms of metal mesh shall be utilized to reduce the accumulation of static electricity. At the same time, the shielding body or metal mesh shall be reliably earthed.

- Explosion-proof electrostatic eliminators shall be used in the area of electrostatic hazards;
- To eliminate static electricity belonging to electrostatic non-conductive materials, different types of electrostatic eliminators shall be used in accordance with the on-site conditions;
- The electrostatic eliminators shall be installed at the location where the charged body is close to the highest potential.

5 Electrostatic Management Measures

5.1 General Requirements

The relevant organizations of the area of electrostatic hazards shall adopt necessary management measures to standardize the various processes and links of electrostatic protection, and the electrostatic protection technology and methods, equipment, appliances and personnel behaviors therein.

5.2 Organizational Management

The relevant organizations of the area of electrostatic hazards shall clearly define the highest manager of electrostatic protection and the electrostatic protection management implementation department.

5.3 Documents

An electrostatic hazard control scheme shall be formulated in the area of electrostatic hazards and become part of the internal management normative documents of the organization. Its content shall at least include:

- Possible electrostatic hazards;
- Manifestations of electrostatic hazards;
- Causes of electrostatic hazards;
- Control measures of electrostatic hazards;
- Personnel training plan;
- Verification of anti-electrostatic measures;
- Relevant records of electrostatic protection behaviors.

5.4 Personnel

Personnel working in the area of electrostatic hazards shall receive regular anti-electrostatic

hazard training. The training shall be combined with the actual work of the organization, and the content shall include training on laws, regulations, standards, implementation methods of anti-electrostatic measures, necessary drills and knowledge supplements.

Non-operating personnel entering the area of electrostatic hazards, including but not limited to short-term visitors, maintenance personnel, cleaning personnel, etc., shall be equipped with publicly available individual anti-electrostatic equipment. Before entering the area of electrostatic hazards, experienced staff shall inform relevant regulations.

5.5 Identification

Related organizations of the area of electrostatic hazards shall identify specific information of electrostatic sensitive objects within the range of operation, identify the range of the area of electrostatic hazards, electrostatic hazardous links, electrostatic protection personnel, supplies, equipment and facilities.

5.6 Inspection

In the work, key data shall be monitored and recorded in real time in accordance with the electrostatic hazard control plan, and the monitoring device shall be regularly measured by a qualified third-party institution. The frequency of inspection, testing and measurement depends on the purpose, durability and risk of failure of the controlled object.

An inspection mechanism for electrostatic protection management shall be established, and corrective measures shall be taken in a timely manner for problems and non-conformities found during the inspection.

5.7 Signs and Records

All areas of electrostatic hazards shall have obvious hazard signs. The signs shall indicate the rating of the area of electrostatic hazards and the entrance and boundaries of the area of electrostatic hazards. The area of electrostatic hazards shall have signs, such as earthing points, anti-electrostatic items that shall be used, necessary clothing, electrostatic hazardous zone and activity restrictions, etc.

Electrostatic sensitive objects and anti-electrostatic packaging / equipment containing electrostatic sensitive objects shall be posted with clear and explicit risk level signs.

All work shall be recorded and preserved.

6 Area of Electrostatic Hazards

6.1 Division of Area of Electrostatic Hazards

When there are explosive mixtures that can be ignited or detonated by static electricity in the environment, or when explosive mixtures that can be detonated by static electricity are directly processed, handled, etc. in the environment, the environment is an area of electrostatic hazards.

In accordance with the probability of explosion accidents caused by static electricity in the workplace, the area of electrostatic hazards is divided into Zone 0, Zone 1, Zone 2 (explosive gas atmosphere) and Zone 20, Zone 21, Zone 22 (explosive dust atmosphere). The division of each zone shall be carried out in accordance with GB 50058.

6.2 Electrostatic Discharge Ignition Limit

6.2.1 The electrostatic discharge energy between conductors is calculated in accordance with Formula (1):

$$W = 1/2(C \times U^2) \quad \dots\dots\dots (1)$$

Where,

W ---the discharge energy, expressed in (J);

C ---the equivalent capacitance between conductors, expressed in (F);

U ---the potential difference between conductors, expressed in (V);

In the atmospheric environment, in accordance with Formula (1), when the discharge energy (W) is greater than the minimum ignition energy (MIE) of the combustible, there is a risk of ignition.

6.2.2 When the potential between two conductor electrodes is lower than 1.5 kV, the alkane petroleum vapor with a minimum ignition energy greater than or equal to 0.25 mJ will not be ignited due to electrostatic discharge.

6.2.3 Inductive corona discharge occurring in a local space, for example, an earthed needle tip will not ignite a combustible gas with a minimum ignition energy greater than 0.2 mJ.

6.3 Charged Object Safety Management Limit

6.3.1 When liquid storage tanks and conveying pipelines made of non-metallic materials are used in explosive atmospheres, the materials used shall satisfy the requirements of surface resistivity less than $1 \times 10^{10} \Omega$ or volume resistivity less than $1 \times 10^8 \Omega \cdot \text{m}$, or other electrostatic protection measures shall be taken.

NOTE: other electrostatic protection measures include the use of electrostatic eliminators and inert gas protection, etc.

6.3.2 The maximum width and surface area of exposed electrostatic non-conductor parts in explosive gas atmosphere shall comply with the provisions of Table 2. If the process requires that the exposed area and the width of the exposed surface of electrostatic non-conductor products exceed the requirements of Table 2, the degree of electrification shall be specifically evaluated, and if necessary, corresponding measures shall be taken. The evaluation process and the measures taken shall be documented and included in the electrostatic protection management system documents.

6.3.3 For solid electrostatic non-conductors without earthing conductors within 15 cm of the back, for combustible gases with a minimum ignition energy greater than 0.2 mJ, the safe potential that does not produce ignition discharge is 15 kV.

7 Solid Material Protection Measures

7.1 When non-metallic electrostatic conductors or electrostatic sub-conductors are connected to metal conductors, the area of close contact shall be greater than 20 cm².

7.2 All constituent parts of the overhead piping system shall maintain reliable electrical connections. Outdoor systems shall also satisfy the requirements of relevant national lightning protection regulations.

7.3 Earthing conductors used on vibrating and frequently moving devices shall not use stranded wires or metal chains, but bare stranded wires or braided wires over 6 mm².

7.4 When using dissipative coating materials to coat non-anti-electrostatic materials, pay attention to the following properties of the coating materials.

- a) It shall be ensured that the dissipative coating cannot be washed off, wiped off, or become ineffective over time. Otherwise, such coating is only suitable as a temporary measure to reduce the accumulation of electrostatic charge.
- b) When adding materials to make the surface absorb moisture to improve surface conductivity, it shall be noted that if the ambient humidity is too low (relative humidity is less than 30%), the materials may become insulating materials and accumulate electrostatic charge.
- c) The dissipative additives used in anti-electrostatic packaging materials shall match the packaged products. If the product absorbs the dissipative additives that it contacts, then, it may cause product contamination and / or loss of packaging dissipative properties.

7.5 For the conveyor belts used to convey or transport solid materials, the materials conveyed to the stub bar or chute through the end of the conveyor belts can carry a large amount of charge, and attention shall be paid to the risk of electrostatic ignition. The conveyor belts used for different occasions and their speed requirements shall comply with the requirements of Table 3. Table 3 does not apply to conveyor belts that dissipate charge through the mode of corona discharge. It shall be noted that conductive or dissipative conveyor belts cannot remove the charge carried by insulating conveyed objects.

Table 3 -- Requirements for Conveyor Belts

Belt Speed	Zone 0	Zone 1		Zone 2	Zone 20		Zone 21	Zone 22
		II C	II A and II B		MIE ≤ 10 mJ	MIE > 10 mJ		

adhesive used to connect the conveyor belts does not interrupt the conductive path.

8 Liquid Material Protection Measures

8.1 Filling and Sampling

8.1.1 The liquid shall be controlled within a safe flow rate range.

8.1.2 When using small portable containers to fill inflammable insulating liquids, metal or electrostatic conductive containers shall be used, and electrostatic non-conductive containers shall not be used. Metal containers and metal funnels shall be bridged and earthed.

8.1.3 When filling light oil, the oil surface potential shall be lower than 12 kV.

8.1.4 The safe static conductivity of light oil shall be greater than 50 pS/m.

8.1.5 When using hoses to convey inflammable liquids, conductive hoses or rubber hoses with metal wires or meshes inside shall be used, and when connecting, attention shall be paid to the conductivity of static electricity.

8.1.6 The oil loading crane pipe, pipeline, and tank truck shall be bridged and earthed. When top loading is adopted, the oil loading crane pipe mouth shall penetrate to no more than 200 mm from the bottom of the tank.

8.1.7 During the conveying and filling process, effective measures shall be taken to prevent the liquid from splashing. The end of the oil filling pipe entering the tank from the bottom or top shall be designed into an inverted T shape that is not easy to cause the liquid to splash, or a guide plate shall be added; when filling from the top, the liquid shall flow down slowly along the side wall.

8.1.8 When filling large containers, for example, tank trucks, with hydrocarbon liquids, the mode of oil filling from the bottom shall be preferred. If the top oil filling is used as a last resort, the oil filling pipe shall extend into the tank no more than 200 mm from the bottom of the tank. During the top oil filling process, before the oil filling pipe is immersed in the liquid surface, its flow rate shall be limited to less than 1 m/s. When the injection port is immersed in 200 mm, the flow rate can be gradually increased, but the maximum flow rate shall not exceed 4.5 m/s. If other effective anti-electrostatic measures (such as anti-electrostatic additives, electrostatic eliminators, etc.) are used, the degree of electrification shall be specifically evaluated. The evaluation process and measures taken shall be documented and become part of the internal management normative documents of the organization.

8.1.9 Tanks that have been filled with highly volatile products, for example, gasoline, shall not be switched to be filled with low-volatile oil products.

8.1.10 The inlet and outlet pipe mouths of light oil products shall be close to the bottom of the oil tank. The classification method of light oil products shall comply with Appendix B.

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