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ICS 29.020

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GB/T 40431-2021

**Guidelines for Personal Safety Restraint in Electrical
Operation Place**

电气运行场所的人身安全约束指南

Issued on: August 20, 2021

Implemented on: March 1, 2022

Issued by: State Administration for Market Regulation;

Standardization Administration of the People's Republic of China.

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Guidelines for Personal Safety Restraint in Electrical Operation Place

1 Scope

This document establishes the principles of electrical personal safety restraint in electrical operation place, and provides the contents and measures of electrical safety restraint for personnel, man-machine interaction and personnel interaction.

This document is applicable to the electrical safety restraint of personnel in places where low-voltage electrical equipment and systems are operated.

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 4025-2010 Basic and Safety Principles for Man-machine Interface, Marking and Identification - Coding Principles for Indicators and Actuators

GB/T 4026-2019 Basic and Safety Principles for Man-machine Interface, Marking and Identification - Identification of Equipment Terminals, Conductor Terminations and Conductors

GB/T 4205-2010 Basic and Safety Principles for Man-machine Interface (MMI), Marking and Identification - Actuating Principles

GB/T 4208-2017 Degrees of Protection Provided by Enclosure (IP code)

GB/T 22696 (all parts) Electrical Equipment Safety - Risk Assessment and Risk Reduction

GB/T 29481-2013 Signs for Electrical Safety

GB/T 33980-2017 Guide on Inclusion of Electrical Safety Aspects in Electro-technical Product Instructions

GB/T 34924-2017 Guidelines for Safety Related Risk Assessment and Risk Reduction for Low Voltage Equipment

3 Terms and Definitions

The following terms and definitions are applicable to this document.

3.1 Electrical Personal Safety

Electrical personal safety refers to the exemption of personnel from injuries caused by various electrical accidents in electrical equipment and systems in the electrical field.

3.2 Restraint

Restraint refers to the proposal of measures to ensure personal safety.

3.3 Collaborative Operation

Collaborative operation specifies the behavior of a specially designed electrical equipment and system in a collaborative workspace with personnel.

[source: GB/T 36008-2018, 3.1, modified]

3.4 Collaborative Workspace

Collaborative workspace refers to a workspace where electrical equipment and systems and personnel can simultaneously execute tasks during production activities in the operation space.

[source: GB/T 36008-2018, 3.3, modified]

3.5 Protective Separation Distance

Protective separation distance refers to the shortest allowable distance between any hazardous movable part of electrical equipment and systems and personnel in the collaborative workspace.

[source: GB/T 36008-2018, 3.6, modified]

4 Principles of Electrical Personal Safety Restraint

The electrical personal safety restraint preferentially complies with the relevant regulations on personal safety protection and the requirements of electrical safety technology for the acceptable risk level of personnel.

The electrical personal safety restraint should be proposed in accordance with the following principles, but are not limited to:

- traceability, which is proposed in accordance with the electrical safety risks confronting personnel in the electrical operation place;
- operability, which is proposed in combination with the performance and application of electrical equipment and systems;
- time-domain characteristics, which considers the movement trajectories and changes of personnel and certain equipment (for example, movable equipment) in the electrical operation place with the passage of time;

---application;

---maintenance and repair.

The electrical safety hazards of electrical equipment and systems are usually triggered by potential risks or unreasonable design in terms of electric shock, energy, ignition, heat, man-machine interface and ergonomics, etc. The relevant electrical safety hazards shall comply with the stipulations of GB/T 22696 (all parts).

The hazard identification of operating scenarios should consider the contents and characteristics of operating scenarios. The operating scenarios may include routine workspace, safety protection space, collaborative workspace and environmental factors throughout the site. Electrical safety hazards of operating scenarios are usually triggered by changes in environmental factors, unreasonable safety distances (for example, protective separation distance in collaborative workspace) and unsafe states, for example, overlapped or intersected movement trajectories.

6 Measures of Electrical Personal Safety Restraint

Electrical safety restraint measures should be taken in accordance with the following priorities during the design stage:

- a) inherent safety measures, which may include inherent safety design measures for electrical equipment and systems, as well as inherent safety measures for personnel;
- b) protective measures, which may include measures proposed for electrical equipment and systems, such as: hazard protection and enclosure protection, etc., as well as measures proposed for personnel, for example, wearing protective equipment;
- c) information of application, including instructions delivered with electrical equipment and systems, safety signs on electrical equipment and systems, safety signs in operation place and operation manuals for personnel, etc.

During the application stage, electrical safety restraint measures should be taken from additional protective equipment, personal protective equipment and training, etc.

7 Electrical Safety Restraint of Personnel

7.1 Personnel Information

The personnel information that should be considered includes, but is not limited to:

- static information: information that does not change or is at the same level within a specific period of time, such as: safety skill level, safety experience, risk awareness and ability to deal with failures, etc.;

---dynamic information: information that changes over the passage of time, such as: physical health status, psychological status, operation / intervention / collaborative operation position (spatial extent of task execution) and movement trajectories, etc.;

---ergonomics information, which includes, but is not limited to:

- whether the characteristics of the common users of the equipment are considered, such as: gender, age, dominant hand, height and strength;
- whether relevant health factors (for example, physical defects like vision or hearing impairment) are considered, and whether continuous adjustments are made in accordance with design improvements.

7.2 Electrical Safety Risks of Personnel

7.2.1 Electrical safety risks triggered by changes of personnel information

Electrical safety risks triggered by changes of personnel static information, dynamic information and ergonomics information (see 7.1).

7.2.2 Electrical safety risks triggered by electrical operation place

Electrical safety risks triggered by electrical operation place may be considered from the following factors, but are not limited to:

- as a result of changes in environmental factors, such as: changes in temperature, pressure, humidity and dust, etc.;
- as a result of unreasonable design of various specific workspaces (routine workspace, safety protection space and collaborative workspace, etc.).

7.2.3 Electrical safety risks triggered by personnel exposure to hazardous situations

Electrical safety risks triggered by personnel exposure to hazardous situations may be considered from the following factors, but are not limited to:

- the frequency and time of personnel entering the hazardous area;
- the frequency and time of personnel holding or touching electrical equipment and systems;
- the cumulative effect and synergistic effect of exposure to the hazardous situation, etc.

7.3 Measures of Electrical Safety Restraint

7.3.1 Inherent safety measures

The inherent safety measures for personnel include, but are not limited to:

- abnormal approaching;
- movement trajectories beyond the safe range, etc.

8.3 Electrical Safety Risks during Manual Intervention

Under some circumstances with auxiliary operations or complex application environments, where automatic implementation through programs is impossible, manual intervention is required. Manual intervention may occur in all relevant stages of the life cycle of electrical equipment and systems (see Chapter 5), such as:

- during the application, when certain functions of automatic and intelligent equipment require manual intervention;
- during the maintenance, when certain functions of trouble-survey require manual intervention;
- when emergency measures are taken, etc.

The electrical safety restraint during manual intervention is proposed for the electrical safety risks generated during this process. Electrical safety risks include unsafe behaviors of personnel (for example, failures to start or stop in accordance with the stipulations, etc.), unsafe states (see 7.1) and electrical safety risks of electrical equipment and systems (see Chapter 5).

8.4 Electrical Safety Risks during Man-machine Collaborative Operation

Usually, man-machine collaborative operation occurs more in the application stage of the life cycle. Man-machine collaborative operation requires the completion of the same task with electrical equipment and systems in a collaborative workspace. It also involves the forms of manual operation and manual intervention.

Therefore, the electrical safety restraint of man-machine collaborative operation shall simultaneously consider the electrical safety risks of manual operation and manual intervention (see 8.2 and 8.3), as well as the electrical safety risks of man-machine collaborative operation.

The electrical safety risks of man-machine collaborative operation should consider:

- electrical safety risks of personnel (see Chapter 7);
- risks caused by changes in the performance of electrical equipment or systems (such as: conditions, loads, speeds and accelerations of normal operation, etc.);
- whether the protective separation distance complies with the requirements;
- whether there are overlaps or intersections of the passage routes (such as: personnel routes, movement routes of electrical equipment or systems, and movement routes of materials to the work area);

---safety protection measures for the collaborative workspace, etc.

8.5 Other Electrical Safety Risks

In addition to the electrical safety risks of manual operation, manual intervention and man-machine collaborative operation, other situations that may generate electrical safety risks should also be considered, which include, but are not limited to:

- accuracy of information acquisition of man-machine interface, such as: digital information, color information and graphic symbol information, etc.;
- accuracy of information acquisition of safety signs on the equipment, such as: prompts, warnings and prohibitory identification information, etc.

8.6 Measures of Electrical Safety Restraint

8.6.1 Inherent safety measures

The inherent safety design measures for electrical equipment and systems include, but are not limited to:

- improve the reliability of electrical equipment and system components;
- improve the electrical insulation structure and insulation coordination, and raise the insulation level, for example: design double insulation, etc.;
- reduce energy;
- reduce the demand for exposure to hazardous situations;
- replace hazardous or detrimental materials and substances;
- improve physical structure, for example, remove sharp edges and corners, etc.

See 7.3.1 for the inherent safety measures for personnel.

8.6.2 Protective measures

The protective measures for electrical equipment and systems include, but are not limited to:

- fixed baffles, guardrails or fences used to prevent approaching or accessing the hazardous area, for example, protection provided by enclosure; the relevant requirements shall comply with the requirements of GB/T 4208-2017;
- chain protection used to prevent accessing the hazardous area;
- emergency stops;
- measures for isolating and dissipating energy, etc.

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