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Code for design of electric vehicle charging station

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Foreword

This Code is based on the requirements of *Announcement on Issuing <2010 Code for the Formulation and Revision Plan of the Engineering Construction Standard> (JB (2010) No.43)* issued by the Ministry of Housing and Urban-Rural Development of the People's Republic of China. It was jointly formulated by State Grid Corporation of China and China Electricity Council, as well as the relevant organizations.

During the formulation of this Code, the drafting team conducts in-depth investigation, seriously summarizes the experience of EV charging station in China, draws lessons from the existing standards of related enterprises in China and relevant standards of foreign developed industrial countries, takes advices extensively, discusses for many times, and finally reviews and finalizes.

This Code is divided into 12 chapters and 1 appendix, which mainly includes the following technical contents: General provisions, terms and symbols, scale and site selection, general plane layout, charging system, power supply and distribution system, power quality, metering, monitoring and communication system, civil engineering, water supply and extinguishing installation for fire-fighting, energy saving and environment protection, etc.

The articles in bold-face marked in this Code are mandatory, which shall be executed strictly.

Ministry of Housing and Urban-Rural Development of the People's Republic of China is responsible for the management and interpretation of the mandatory provisions; the China Electricity Council is responsible for daily management; and the State Grid Corporation of China is responsible for the interpretation of the specific technical contents. If the specification needs to be revised and supplemented during the enforcement, please mail the opinions and suggestions to the State Grid Corporation of China (Address: No.86, West Chang'an Road, Xicheng District, Beijing, Postal code: 100031) for the reference of future revision.

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Chief drafting organizations:

State Grid Corporation of China

China Electricity Council

Participating drafting organizations:

Beijing Economic and Technological Institute of Electric Power

Code for design of electric vehicle charging station

1 General

1.0.1 In order to make the design of electric vehicle charging stations implement the relevant national policies and guidelines, unify the technical requirements, and to be safe and reliable, technologically advanced and economic reasonable, hereby this Code is formulated.

1.0.2 This specification applies to the design of electric vehicle charging stations using vehicle charging mode.

1.0.3 The design of electric vehicle charging stations shall comply with the following principles:

1 Implementing national laws and regulations, and complying with the requirements of regional and national economy and social development planning.

2 Coordinating with the local regional master plan and the town planning.

3 Complying with the requirements of fire safety, electrical safety and environmental protection.

4 Actively and steadily using new technology, new equipment and new materials to promote technological innovation.

1.0.4 In addition to complying with this Code, the design of the electric vehicle charging stations shall comply with the provisions of existing national standards.

2 Terms and symbols

2.1 Terms

2.1.1 Vehicle charging mode

The manner of directly connecting the electric vehicle to the charging equipment through connection set for charging.

2.1.2 EV charging station

Sites where provide electric energy to electric vehicle using vehicle charging mode shall include the charging equipment for 3 sets and more electric vehicles (at least one off-board charger), related power supply units, monitoring equipment and other support equipment. Hereinafter referred to as charging station.

2.1.3 Charging system

System that is consisted of all charging equipment, cables and related auxiliary equipment within the charging stations.

2.1.4 Charging equipment

Equipment that connects to the electric vehicle or power storage battery, and supplies power for them, including on-board charger, off-board charger, AC charging piles and other equipment.

2.1.5 Off-board charger

Special equipment that is rigidly installed on the ground converting the grid AC power to DC power and charging power to the electric vehicle power storage battery by use of the conduction mode.

2.1.6 AC charging piles

Special equipment that uses conduction mode to provide AC electric energy for electric vehicles with on-board charger.

2.1.7 Battery management system (BMS)

A system that can control the battery input and output power, monitor battery state (temperature, voltage, state of charge), and provide communication interface for the battery.

2.1.8 Monitoring system of charging station

A system that collects information on the operating conditions, environmental monitoring, warning, etc. of power supply unit and charging equipment in the charging station, and using computer and network communication technology to monitor, control and manage the equipment in the station.

2.2 Symbols

2.2.1 Charger output voltage:

n — The number of series battery monomers for power storage battery of electric vehicle;

K_u — Margin coefficient of output voltage of the charger;

U_{cm} — Maximum voltage of monomer battery (V).

2.2.2 DC rated current output of the charger:

K_c — Margin coefficient of output voltage of the charger;

I_m — Maximum allowable continuous charging current of power storage battery of electric vehicle (A).

3 Scale and site selection

3.1 Scale

3.1.1 Determine the layout of the charging station comprehensively based on the type and inventory of the electric vehicle. Make full use of power supply, communication, fire-fighting, drainage and other public facilities.

3.1.2 Determine the scale of the charging station comprehensively based on the charging demand of the electric vehicle, the average daily mileage and the energy consumption levels of per unit mileage of the vehicle.

3.2 Site selection

3.2.1 The overall plan of the charging station shall comply with the requirements of town planning and environmental protection, and the charging station shall be located in a place with convenient transportation.

3.2.2 The site of the charging station shall be close to the urban road, and shall not be located in intersection and the vicinity of the heavy traffic road.

3.2.3 Selection of the site of the charging station shall base on the planning and construction of middle and low voltage distribution network to meet the requirements of power distribution reliability, power quality and automation.

3.2.4 The charging station shall comply with the requirements of environmental protection and fire safety. Fire hazard classification of the buildings and the structures of the charging station shall comply with relevant requirements of *Code for Design of Fire Protection for Fossil Fuel Power Plants and Substations* (GB50229) and C*ode of Design on Building Fire Protection and Prevention* (GB50016). The fire break between the buildings and structures in the charging area and the power distribution room in the charging station and the buildings outside the charging station shall comply with relevant requirements of *Code of Design on Building Fire Protection and Prevention* (GB50016) and *Code for Fire Protection Design of Tall Buildings* (GB50045). Classification of categories of workshops of the buildings and structures in the charging station shall comply with the provisions of Table 3.2.4.

5 Charging system

5.1 Off-board charger

5.1.1 The selection for output voltage of the off-board charger shall comply with the following requirements:

1 Determine the highest charging voltage of the charger according to the characteristics of power storage battery of the electric vehicle and the number of series battery monomers.

2 The following three levels shall be selected in priority for the charger DC output voltage range: 150V-350V, 300V-500V and 450V-700V.

3 The charger output voltage (U_f) can be calculated as follows:

$$U_r=nK_uU_{cm} \quad (5.1.1)$$

Where: n — The number of series battery monomers for power storage battery of electric vehicle;

K_u — The charger output voltage margin coefficient shall be taken as 1.0-1.1;

U_{cm} — Maximum voltage of monomer battery (V).

4 Charger DC output voltage range shall be determined based on the group of which the maximum voltage equal to or greater than Ur grade in the voltage optimization range.

5.1.2 The selection for output current rating of the off-board charger shall comply with the following requirements:

1 According to the capacity of the power storage battery of the electric vehicle, the charging speed, the power supply capacity and the cost performance of the equipment, on the premise of ensuring safe and reliable charging, determine the maximum charging current.

2 The following values shall be used in priority for the charger DC output rated current: 10A, 20A, 50A, 100A, 160A, 200A, 315A and 400A.

3 The charger DC output rated current (Ur) can be calculated as follows:

$$Ur=K_cI_m \quad (5.1.2)$$

Where: K_c — The charger output voltage margin coefficient shall be taken as 1.00-1.25;

the power supply wiring of multiple AC charging piles.

3 The floor type or wall mounting type and other installation types can be used. The installation base of floor type charging pile shall be 0.2m and above higher than the ground and the crash barrier can be installed if necessary.

4 The protective earthing terminal shall be reliably grounded.

5 The necessary measures of rainproof and dustproof shall be taken for the outdoor charging piles.

6 Power supply and distribution system

6.1 Power requirement

6.1.1 The power supply and distribution system of the charging station shall comply with the relevant regulations of *Code for Design Electric Power Supply Systems* (GB50052).

6.1.2 The medium-voltage lines shall be used to supply power for charging stations; when the capacity of the utilization equipment is 100 kw and below or the capacity of the transformer is below 50kVA, use low voltage power supply.

6.2 Power supply and distribution

6.2.1 Layout of power supply and distribution sets shall comply with the relevant regulations of *Code for Design of 20kV and below Substation* (GB50053), follow the principles of safety, reliability and suitability to facilitate installation, operation, handling, maintenance and debugging. When the construction site is limited, the medium and low voltage switch cabinets can be provided in the same room, and the transformer shall be flame retardant or non-combustible type, its enclosure protection grade shall not be lower than IP2X.

6.2.2 The power distribution system shall comply with the following requirements:

1 Medium and low-voltage distribution system shall use single bus-bar or sectionalized single-bus wiring. Low-voltage grounding system shall use TN-S system.

2 The circuit breaker shall be used for the low-voltage inlet and outlet switch and the section switch. Install mechanical latching and electric interlocking installations between low voltage incoming line circuit breaker and low voltage section breaker of different power supply to prevent different power supplies in parallel operation.

3 Low voltage incoming line circuit breaker shall have short circuit instantaneous, short circuit short time delay, short circuit long time delay and ground protection functions, and be provided with shunt trip device. Shall not provide no-voltage trip device or low-voltage trip device.

system impedance, compensating the reactive power, and adjusting the three-phase load equalization, etc.

7.0.3 The limiting values of the voltage fluctuation and flicker generated in the charging station on the points of common coupling of the power grid should comply with the relevant provisions of current national standard of *Power Quality—Voltage Fluctuation and Flicker* (GB/T12326).

7.0.4 When the fluctuating load of the charging station causes the voltage fluctuation and flicker, use dynamic reactive compensation equipment or dynamic voltage regulation device and other measures to improve. For charging station with larger power chargers, use power grid of larger short circuit capacity to supply power.

7.0.5 The harmonic component generated by connecting the charger and other nonlinear utilization equipment in the charging station to the grid power shall comply with the relevant provisions of current national standard of *Electromagnetic Compatibility - Limits - Limits for Harmonic Current Emissions (Equipment Input Current ≤16 A Per Phase)* (GB17625.1) and *Electromagnetic compatibility – Limits - Limitation of Emission of Harmonic Currents in Low-voltage Power Supply Systems for Equipment with Rated Current Greater than 16A* (GB/Z17625.6).

7.0.6 The harmonic current used when connecting to the power grid and the voltage sine distortion factor causing point of common coupling should comply with the relevant provisions of current national standard of *Quality of Electric Energy Supply Harmonics in Public Supply Network* (GB/T14549).When needing to reduce or control the harmonics connecting to the public grid and the voltage sine distortion factor of point of common coupling, take measures to improve, such as installing filter.

7.0.7 In the power supply and distribution system of the charging station, the allowable three-phase voltage imbalance limiting values of the point of common coupling should comply with the relevant provisions of current national standard of *Power Quality - Three-phase Voltage Unbalance* (GB/T15543).When the degree of three-phase unbalance of the low-volatile distribution system of the charging station does not meet the requirements, adjust the low voltage single-phase charging equipment connecting to the three-phase system of the charging station to balance the three phases.

8 Metering

8.0.1 The off-board charging of electric vehicles should be measured in DC measurement. The DC measurement should comply with the following requirements:

1 When using electronic type DC energy meter (hereinafter referred to as the DC energy meter) and shunt, should install them between the DC side of the off-board charger and the electric vehicle, the accuracy class of DC energy meter should be 1.0, and the accuracy class of shunt should be 0.2.According to the charging

unrelated to metering should not access between the electric energy meter and the on-board charger.

4 The AC charging piles should be able to collect data from AC electric energy meter, calculate the charge capacity, display charging time, charge capacity and charging fees and other information;

5 The AC charging piles should show charge capacity for this time, and can reset the number to zero;

6 The AC charging spot can record the charging behaviors for at least 100 times, and the recorded content include starting time of charging, electric quantity value at starting time, ending time, electric quantity value at ending time and charge capacity;

7 The data collected by AC charging piles from the AC electric energy meter should be consistent with the corresponding display contents of users.

9 Monitoring and communication system

9.1 System construction

9.1.1 The System construction shall comply with the following requirements:

1 The monitoring system of charging station should consist of station layer, spacer layer and network equipment. According to Appendix A of this specification, carry out structural design of the monitoring system. Simplify smaller charging station according to the actual needs.

2 The station layer shall implement man-machine interaction in various systems running in the charging station to realize collection and real-time display of related information, remote control of the devices and storage, query and statistics of data, and communication with related systems.

3 The spacer layer should be able to collect the running status and operating data of the equipment, and have the functions of uploading to the station layer, receiving and executing the control commands of the station layer.

9.1.2 The selection for configuring the following equipment can be based on the scale and hardware composition of charging station:

1 Station level equipment: Server, workstation and printer.

2 Spacer layer equipment: Charging equipment measure and control unit, power supply and distribution equipment measure and control unit and security terminal.

3 Network devices: Network switching equipment, communication gateway,

event logging functions.

9.2.6 Charging monitoring system should provide one or several alarm ways of graphics, text, voice, etc. and have corresponding alarm processing functions.

9.2.7 Charging monitoring system should have the equipment operation management functions of recording, counting and inquiring all kinds of running parameters and running status.

9.2.8 Charging monitoring system can stipulate the operators' range of application and operation rights to a variety of business activities to realize user management and authority management functions.

9.2.9 Charging monitoring system can define all kinds of daily reports, monthly reports and annual reports to realize report form management function, timed printing and calling printing functions.

9.2.10 The charge monitoring system shall have the following scalability:

1 The system shall have a stronger compatibility in order to complete access to charging equipment of different types.

2 The system shall have the scalability in order to meet the requirements for continuous expansion of the charging station scale.

9.2.11 The charging monitoring system can accept system clock synchronization, in order to ensure the consistency of system time.

9.3 Power supply monitoring system

9.3.1 Power supply monitoring system should collect the information on-off states, guard signals, voltage, current, active power, reactive power, power factor and electric energy metering of the charging station's power supply system.

9.3.2 The power supply monitoring system shall be able to control the switch of power supply system load or circuit breaker.

9.3.3 The power supply monitoring system of larger charging station should have the functions of off-limit alarm, logging out and fault statistics of power supply system.

9.4 Security and protection monitoring system

9.4.1 The design of the charging station's security and protection monitoring system should comply with the relevant provisions of current national standard for Engineering of Security and Protection System (GB 50348), and should set video security and protection monitoring system, with intrusion alarm system and access control system.

9.4.2 Design of video security and protection monitoring system should comply with the

10.1.3 Fire resistance rating of buildings and structures in the charging station should meet the relevant provisions of current national standard of *Design on Building Fire Protection and Prevention* (GB 50016). When the supporting member of the awning ceiling is the steel structures, its fire resistance can be 0.25h and the combustible component shall not be adopted for the other parts of the ceiling.

10.1.4 The charging station buildings should be in harmony with the surrounding environment, the size should be structured, and concavo-convex surfaces should not too much.

10.1.5 The design of the monitoring room should comply with the following requirements:

1 The monitoring room should be set separately. When forming an integrated building, the monitoring room should be set on the ground floor.

2 The anti-static measures shall be taken for the ground of monitoring room.

10.2 Water supply and drainage

10.2.1 Design of domestic water supply and drainage should comply with the relevant provisions of current national standard for *Design of Building Water Supply and Drainage* (GB 50015).

10.2.2 The rainwater in the station area is drained into the municipal rainwater system after collecting by catch water or gully. The rainwater drainage system shall use an organized drainage method. When the centralized drainage conditions are insufficient, the ground rainwater in the station can be dispersed and drained outside the station.

10.2.3 The domestic sewage of charging station shall be drained to the municipal sewage pipe by septic tank. When the sewage in the charging station cannot meet natural drainage requirements, provide sewage treatment plant in the charging station, and drain the sewage after it reaching the standard.

10.3 Heating, ventilation and air conditioning

10.3.1 Design of heating, ventilation and air conditioning of the charging station should comply with the relevant provisions of current national standard for *Design of Heating, Ventilation and Air Conditioning* (GB 50019).

10.3.2 Rooms of buildings should use natural ventilation method, rooms of special ventilation requirement can use mechanical ventilation method.

10.3.3 The charging station located in the heating zone shall use dispersed electric heating method. When using electric heating, the requirements of room use and security and fire prevention shall be met.

10.3.4 Air conditioning rooms should use split type air conditioners, and the air

and power distribution room. The evacuation channel shall be equipped with illumination device, and the evacuation channel and entrance shall be equipped with evacuation indication signal lamp.

11 Water supply and extinguishing installation for fire fighting

11.0.1 Electric vehicle charging stations within the buildings meet the fire resistance rating is lower than the secondary, the volume is greater than 3000 m^3, and fire hazard for non E class, charging station should be set fire water system. The firefighting water source shall have reliable assurance.

11.0.2 Design of the electric vehicle charging station's fire water supply system should comply with the relevant provisions of current national standard of *Design on Building Fire Protection and Prevention* (GB 50016). Number of fires at the same time should be deemed as one.

11.0.3 The buildings in the electric vehicle charging station shall meet the following conditions which indoor fire hydrant cannot be set:

1 Category D or E buildings containing less combustible materials whose fire resistance classification is Class 1 or Class 2.

2 Class D buildings with the fire resistance rating of III or IV and the building volume of no more than 3000 m^3 and Class E buildings with the fire resistance rating of III or IV and the building volume of no more than 5000 m^3.

3 Without indoor production and domestic water supply piping is provided in the building, and the outdoor firefighting water is taken from water storage reservoir and whose architectural volume does not exceed 5000 m^3.

11.0.4 The configuration of the fire extinguisher in the building shall comply with the relevant provisions of current national standard of *Design of Extinguisher Distribution in Buildings* GB 50140 The configuration of fire extinguishers in outdoor charging area shall meet the following requirements:

1 Regardless of plug-in hybrid electrical vehicle entering, the charging station shall be equipped with fire extinguishers according to the light risk levels.

2 Considering the plug-in hybrid electrical vehicle entering, the charging station shall be equipped with fire extinguishers according to the serious risk levels.

12 Energy-saving and environment protection

12.1 Energy-saving of buildings, equipment and materials

12.1.1 During the planning, design and construction of the charging station, you shall implement the national energy-saving policy and reasonably use the energy.

12.1.2 The buildings shall use energy-saving and environment-friendly construction materials, and the solid clay brick cannot be used. Equipment rooms shall have natural ventilation and natural lighting function.

12.1.3 Power distribution room shall use energy-saving transformers.

12.2 Noise control

12.2.1 Influence of the charging station's noise on the surrounding environment should comply with the relevant provisions of current national standard of *Environmental Quality Standard for Noise* (GB3096).

12.2.2 The noise in the charging station shall be controlled from sound source, and it is preferred to use low-noise equipment.

Explanation of wording in this Code

1 Words used for different degrees of strictness are explained as follows in order to mark the difference in executing the requirements in this Code:

1) Words denoting a very strict or mandatory requirement:

"Must" is used for affirmation; "must not" for negation.

2) Words denoting a strict requirement under normal conditions:

"Shall" is used for affirmation; "shall not" for negation.

3) Words denoting a permission of a slight choice or an indication of the most suitable choice when conditions permit:

"Should" is used for affirmation; "should not" for negation.

4) "May" is used to express the option available, sometimes with the conditional permission.

2 "Shall be in accordance with " or "shall execute based upon " is used in this Code to indicate that it is necessary to comply with the requirements stipulated in other relative standards and codes.

List of quoted standards

GB 50015 Code for design of building water supply and drainage

GB 50016 Code of Design on Building Fire Protection and Prevention

GB 50019 Code for design of heating ventilation and air conditioning

GB 50045 Code for fire protection design of tall building

GB 50052 Code for design electric power supply systems

GB 50053 Code for design of 20kV and below electric substation

GB 50058 Electrical installations design code for explosive atmospheres and fire hazard

GB 50140 Code for design of extinguisher distribution in buildings

GB 50229 Code for design of fire protection for fossil fuel power plants and substations

GB 50348 Technical code for engineering of security and protection system

GB 50394 Code of design for intrusion alarm systems engineering

GB 50395 Code of design for video monitoring system

GB 50396 Code of design for access control systems engineering

GB 3096 Environmental quality standards for noise

GB/T 12326 Power quality - Voltage fluctuation and flicker

GB/T 14549 Quality of electric energy supply - Harmonics in public supply network

GB/T 15543 Power quality - Three-phase voltage unbalance

GB 17625.1 Electromagnetic compatibility – Limits - Limits for harmonic current emissions (equipment input current ≤16 A per phase)

GB/Z 17625.6 Electromagnetic compatibility – Limits - Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16A

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