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Foreword

These rules are prepared in accordance with the *Notice on Issuing the Plan of Preparation and Amendment of Electric Power Industry Standards in 2002* issued by the former State Economic and Trade Commission (GJMDL (2002) No.973).

These rules are prepared to regulate the design of urban underground substations such that they are technically advanced, economically viable, convenient for operation and maintenance and can supply power in a safe and reliable manner.

These rules contain the principled provisions on the relevant issues regarding the design of 35 kV-220 kV substation and is developed based on GB 50059 *Design code for substation (35 kV-110 kV)*, SDJ 2 *Technical code for designing 220-500 kV substation* and with reference to the relevant national standards and electrical power industry standards.

These rules are prepared in the background that the design and construction of underground substations are not popular in China and through gathering experiences in respect of design, operation, and management from Beijing, Shanghai, Shandong and other regions.

These rules are proposed by China Electricity Council.

These rules are under jurisdiction of and interpreted by the Technical Committee on Electric Power Planning and Engineering of Standardization Administration of Power Industry.

These rules are mainly drafted by Beijing Electric Power Design Institute.

The organizations participating in drafting these rules include

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Shanghai Electrical Power Design Institute Co., Ltd. and Shandong Electric Power Engineering Consulting Institute Co., Ltd.

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These rules are translated by SUNTHER Translation & Solutions under the authority of China Electric Power Planning & Engineering Association.

1 Scope

These rules specify the general technical requirements for design of urban underground substations with respect to selection of station site, layout of station area, electrical wiring, structure of buildings, environmental protection as well as the special technical requirements with respect to transportation of equipment, air ventilation, water proofing and fire prevention.

These rules apply to the design of 35 kV-220 kV urban underground substation.

2 Normative References

The following normative documents contain regulations which, through reference in this text, constitute regulations of this rule.

For dated references, subsequent amendments (excluding the contents of errata) to, or revision of, any of these publications do not apply. However, parties to agreements based on these rules are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below.

For undated references, the latest edition of the normative document referred to applies.

GB 3096 *Standard of Environmental Noise of Urban Area*

GB 8702 *Regulations for Electromagnetic Radiation Protection*

GB 8978 *Integrated Wastewater Discharge Standard*

GB 14285 *Technical Code for Relaying Protection and Security*

Automatic Equipment

GB 50007 *Code for Design of Building Foundation*

GB 50011 *Code for Seismic Design of Buildings*

GB 50015 *Code for Design of Building Water Supply and*

Drainage

GB 50019 *Code for Design of Heating Ventilation and Air*

Conditioning

GB/T 50034 *Standard for Lighting Design of Buildings*

GB 50059 *Design Code for Substations (35 kV-110 kV)*

GB 50060 *Design Code for High Voltage Electrical Installation (3-110 kV)*

GB 50108 *Technical Code for Waterproofing of Underground*

Works

GB 50116 *Code for Design of Automatic Fire Alarm System*

GB 50217 *Code for Design of Cables Electric Work*

GB 50222 *Code for Fire Prevention in Design of Interior*

Decoration of Buildings

GB 50227 *Code for Design of Installation of Shunt Capacitors*

GB 50229 *Code for Fire-protection Design Power Plant and*

Substation

GB 50260 *Code for Design of Seismic of Electrical Installations*

GBJ 16 (2001 Edition) *Code of Design on Building Fire Protection and Prevention*

DL/T 620 *Overvoltage Protection and Insulation Coordination for AC Electrical Installations*

DL/T 621 *Grounding for AC Electrical Installations*

DL/T 5003 *Specifications for the Design of Dispatch Automation in Electric Power Systems*

DL/T 5044 *DC System Technical Code for Designing Fossil Fuel Power Plants and Substation*

DL/T 5056 *Technical Code of General Plan Design for Substation*

DL/T 5120 *DC System Design Code for Small Electric Power Project*

DL/T 5136 *Technical Code for Designing of Electrical Secondary Wiring in Fossil Fuel Power Plants and Substations*

DL/T 5137 *Technical Code for Designing Electrical Measuring and Energy Metering Device*

DL/T 5149 *Technical Code for Designing Computerized Monitoring and Control System of 220 kV-500 kV Substations*

DL/T 5155 *Technical Code for Designing AC Station Service*

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of 220 kV-500 kV Substation

JGJ 120 *Technical Specification for Retaining and Protection of Building Foundation Excavations*

SDJ 2 *Technical Code for Designing 220-500 kV Substations*

SDJ 5 *Technical Code for Designing High Voltage Electrical Switchgear*

NYD (1993) No.228 *Code of Planning and Design of Urban Electric Network*

3 Terms and Definitions

The following terms and definitions apply to this rule.

3.0.1

Underground substation

Underground substation includes fully underground substation and partially underground substation whose buildings may be built independently or in combination with other buildings (structures).

3.0.2

Fully underground substation

Main buildings of the substation are built underground and the main transformers and other main electrical equipment are installed in underground buildings. Above the ground level only a few buildings are arranged, such as the ventilation opening and equipment, personnel entrances/exits as well as the cooling equipment of large-sized main transformers and main control room possibly located above the ground level.

3.0.3

Partially underground substation

Underground buildings dominate this type of substations and the main transformers and other main electrical equipment are installed in underground buildings.

4 General

4.0.1 Underground substation is a special type of substation which is built in cases where a substation above the ground level cannot be built in a conventional way. The substation can be built independently or in combination with other buildings (structures).

4.0.2 The underground substation shall be designed on the basis of the grid planning for not less than 10 years, have its final size determined in accordance with the grid structure and nature of the substation, and have its civil works completed once for all.

4.0.3 The design of underground substation must be closely tied to the urban planning and overall planning of underground buildings, taking into account the overall situations comprehensively. The design scheme of fully underground substation or partially underground substation shall be determined comprehensively taking into account the factors including project scale, overall layout of the substation, ventilation of underground buildings, fire fighting, transportation of equipment, personnel entrances/exits as well as environmental protection.

4.0.4 The equipment for the underground substation shall be of approved product with excellent quality and reliable performance and shall be selected by adherence to the principle of ensuring that they are appropriately leading, safe and reliable, technically advanced and cost effective while placing emphasis on the miniaturization, oil-free, automation and less or free of maintenance of the equipment.

4.0.5 The design of underground substation must adhere to the principle of “reducing the land use to the minimum”, endeavoring to

reduce the work quantities of building blocks so as to save construction land and control project construction costs.

4.0.6 The underground substation must be soundly designed in respect of equipment transportation, water proofing and drainage of buildings, ventilation, and fire fighting.

4.0.7 The seismic design of underground substations shall comply with the provisions of GB 50011 and GB 50260.

4.0.8 In addition to this rule, the design for underground substations shall comply with the relevant national laws, regulations, standards, the standards of electric power industry, and the local standards.

5 Station Site Selection and Station Area Layout

5.1 Station Site Selection

5.1.1 In areas where the urban electrical loads are concentrated while the conditions for construction of above-ground substations are limited, the underground substation may be built independently utilizing the urban green space and the ground-level facilities, such as play grounds and parking lots. Alternatively, it may be built in combination with other industrial or civil buildings (structures).

5.1.2 The site of underground substation shall be selected by closely coordinating with urban planning authorities so that the ground-level roads, underground pipelines and cable raceways are planned in a unified way for ease of transportation and lifting of equipment and installation of incoming and outgoing cable lines.

5.1.3 The station site shall enjoy favorable hydrological and geological conditions for construction of underground buildings (e.g., it shall be clear of seismic fracture zone, subsidence area, and other unfavorable geologic structures). Additionally, the station site shall not be located at the places where cultural relics are spotted underground or above the ground level.

5.1.4 When selecting station site, the mutual influences between the substation and neighboring surroundings and adjacent facilities shall be considered.

5.1.5 In addition to the limiting conditions of equipment transportation roads outside the substation area, such as turning radius, transportation height, the bearing capacity of underground

facilities below the transportation roads of the neighboring areas shall be checked as well.

5.2 Station Area Layout

5.2.1 The layout of above-ground-level buildings (structures), roads and underground pipelines of underground substation shall be in harmony with the urban planning.

5.2.2 The general layout of an underground substation shall be as compact as possible on the premise that the technological requirements are met, comprehensively taking into account the various factors including equipment transportation, ventilation, fire fighting, installation and repair, operation and maintenance as well as personnel evacuation. When the substation is built in combination with other buildings (structures), the relevant conditions of these buildings (structures) shall be fully utilized such that they are designed from an overall view.

5.2.3 The fire fighting access and fire prevention space between the above-ground-level buildings (including those built in combination with other buildings) of underground substation and the adjacent buildings shall comply with the provisions of GBJ 16.

5.2.4 The setting of ground-level roads in the station area shall comply with the provisions of DL/T 5056.

5.2.5 The number of emergency exits of underground substation shall not be less than two, and, if conditions permit, the adjacent buildings may be utilized to dispose the emergency exits.

5.2.6 The main control room of the underground substation should be arranged above the ground level if the conditions permit. Where the conditions do not permit, it shall be arranged below the ground level and should be located proximate to the ground surface. For

large-scale underground substations with multiple stories, passenger elevators may be installed.

5.2.7 The air inlet and air outlet of underground substations shall be disposed separately. The air inlet should be disposed at the windward side of the summer prevailing wind direction.

5.2.8 For underground substations, lifting openings should be respectively provided for large-sized and small-sized equipment. The lifting opening for large-sized equipment is used for lifting large-sized equipment such as transformers. It may be integrated with the air inlet. The lifting opening for small-sized equipment is permanently provided and used for routine lifting of the repair and test equipment and small-sized equipment.

5.2.9 The lifting opening for large-sized equipment shall be located such that it suits the working conditions of large transportation and lifting vehicles used for the transportation of the substation equipment.

5.2.10 Oil-immersed power transformers arranged indoors in underground substation should be installed in a separate explosion-proof room.

5.3 Cable Raceways for Incoming and Outgoing Lines

5.3.1 The power cable raceways of underground substations shall be commensurate with the number of outgoing cables and have appropriate margin reserved. Where conditions permit, the power cables of the substations should be led into the substation through different cable raceways.

5.3.2 Where power cable mezzanines of underground substations are arranged at relatively deep locations, the cables may be led up through cable shaft and then connected with cable tunnels (ducts)