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P DL / T 5429 — 2009
To replace SDJ 161 — 1985

Technical Code of Design for the Electric Power System

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Foreword

This code is a revision to SDJ 161—1985 *Technical Code of Design for Electric Power System* (trail) in accordance with the *Notice regarding Printing and Distributing the Plan for Revision and Establishment of* 2007 *Industry Standards Issued by the General Office of the National Development and Reform Commission* (FGBGY [2007] No.1415).

Since its promulgation and implementation, the standard SDJ 161—1985 has been playing a guiding role in the planning and design of the electric power system, and has become the basic designing guidelines for the planning and engineering personnel of the electric power system. With the technical progress of the electric power system, the increasing expansion of grid scale, the further extension of nationwide networking, and the ongoing deepening of reform on power industry commercialization system, some articles of the original code need to be revised and enriched due to their failure to meet the requirements of the design of electric power system any longer. This code is revised for better planning and design of electric power system.

Relevant articles are revised based on SDJ 161—1985 while referring to relevant national and power industry standards currently in force, summarizing the practical experiences of implementation of the original code in the past, and in conjunction with the requirements at various stages including the design of electric power system (primary part), the studies on special topics of electric power system, the design of connecting power plants, substations and converter stations to systems, the feasibility studies on power generation, transmission and transformation projects as well as the system part of preliminary design.

Considering the technical progress of electric power system, the expansion of grid scale, and the reform on electric power commercialization, the relevant articles of the original code are mainly enriched and modified as follows:

——Add the chapter of prediction on electric power demand;

——Revise the system reserve capacity;

——Add the requirements that the grid design shall comply with DL 755—2001 *Guidelines for Safety and Stability of Electric Power System*;

——Add requirements for safety and stability of nuclear power plants connected to the system;

——Add the specific requirements for the power factor and leading phase of generators.

The code will replace SDJ 161—1985 after implementation.

This code was proposed by China Electricity Council.

This code is under jurisdiction of and explained by the Technical Committee on Electric Power Planning and Engineering of Standardization Administration of Power Industry.

The code was drafted by Northeast Electric Power Design Institute under China Power Engineering Consulting Group Corporation.

The leading authors of this code are: Li Zhiguo, Guo Jia, Wu Jingkun, Fu Guang and Tan Yongcai.

The code was initially issued on September 24, 1985 and this is the first revision of this code.

The opinions and suggestions proposed during the implementation of this code are to be referred to the Standardization Center of China

Electricity Council (at the following address: No.1, Ertiao, Baiguang Road, Xuanwu District, Beijing, 100761).

This code is translated by SUNTHER Translation & Solutions under the authority of China Electric Power Planning & Engineering Association.

1 Scope

This code specifies the basic requirements for the design of electric power system, including power demand forecast, design of power source and grid schemes, calculation of power flow, phase modulation and voltage regulation, system stability, short-circuit current, power frequency over-voltage and secondary arc current, as well as the comparison of various schemes in terms of economy.

This code is applicable to design of electric power system of 220 kV and above (primary part), to the study on special topics of electric power system, the design for connecting power plants, substations and converter stations to the system, the feasibility study on power generation, transmission and transformation projects as well as preliminary design of system part.

2 Normative References

The following normative documents contain provisions which, through reference in this text, constitute provisions of this code. 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 this code 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.

DL 755 *Guidelines for Safety and Stability of Power Systems*

SD 325 *Technical Guidelines for Voltage and Reactive Power of Power Systems* (*trial*)

Provisional Regulations for Economic Analysis of Electric Power Projects, issued by the former Ministry of Water Resources and Electric Power (Dianjizi [82] No.44)

3 General

3.0.1 The design of power systems shall follow the industrial policy, development guiding principle and various technical and economic policies of the electric power industry and shall be market-oriented, on the grounds of safety and stability and in line with the fundamental principle of optimal allocation of energy resources such that the design is scientifically demonstrated, technically advanced and economically viable.

3.0.2 The design of an electric power system shall be based on power industry planning, grid planning, and transmission system planning of the power plants. The detailed development scheme shall be further studied and proposed while taking into account the overall conditions of the electric power system.

3.0.3 The layout of the power sources and power grid shall be considered reasonably when designing the power system to ensure that the power generation, transmission, transformation projects and reactive power supply can be built in a coordinated manner and lay a foundation for design of relay protection, design of power system safety automatic control devices, communication design, dispatching automation, and design of electric power system of a lower rated voltage level.

3.0.4 The safe and stable operation of an electric power system prerequisites a reasonably designed grid structure. While ensuring the safe and stable operation of the system and satisfying the demands for power market development, the design shall consider all the factors comprehensively to achieve a reasonable layout of the power grid such that the weak links can be eliminated, the main grid can be strengthened, the power grid at the sending end can be simplified and the anti-disturbance ability of the power grid can be improved.

3.0.5 The design of the power system shall provide the basis for study on special topics of power system, the design of connecting power plants, substations and converter station into the system, feasibility study on power generation, transmission and transformation projects, the system part of the preliminary design as well as the next stage of system design.

3.0.6 The specific tasks of designing an electric power system are to:

1 Analyze and propose the level, distribution, composition and characteristics of the electric power demand.

2 Balance the electric power and energy, and further demonstrate the reasonable range served by the power system and associated networking schemes, power source building schemes as well as system peak regulation scheme.

3 Demonstrate the grid construction schemes, including voltage level, grid structure, and transitional measures.

4 Carry out electrical calculation on the power grid, and then propose the technical measures for ensuring voltage quality and safety and stability of the system.

5 Propose the commissioning time of power generation, transmission and transformation projects and reactive power supply, quantity and main specifications of major equipment, and perform investment estimation.

6 Propose the special topics requiring further study.

The above tasks can be carried out in a targeted manner by stages according to the specific conditions, while taking into account the situations comprehensively.

3.0.7 The design level year of the electric power system should be in conformity with the planning year of national economy and society development, generally being taken as a year after around five years from now on, and a year after 10-15 years from now on for future outlook.

4 Electric Power Demand Forecast

4.0.1 The electric power demand forecast comprises of analysis on current situation of power demand, electrical energy demand forecast, power load forecast, and load characteristics forecast.

4.0.2 The electric power demand forecast shall be based on the national economic development and social development planning through electric power market investigation and research, collection of the current and historical information related to power demand and research on the relationship between the power demand and national economic social development as well as environmental protection. By analyzing the inherent law of power demand and keeping pace with the market development trend, one can forecast the future electrical energy demand, power load, and load characteristics.

4.0.3 The electric power demand forecast may be made using electricity consumption per unit output method, growth rate method, elasticity coefficient method, regression analysis method, time series method, and specialist forecast method. Depending upon the actual situations, three or more of these methods shall be selected for the forecast and shall be checked against each other. Two or three forecast levels shall be proposed and a comprehensive analysis be made to recommend a level.

4.0.4 Power load curves shall be developed with the characteristic indices given below:

1 Daily load curve and characteristic indices: daily load factor γ, daily minimum load factor β.

2 Annual load curve and characteristic indices: monthly imbalance factor σ, seasonal imbalance factor ρ, load static state declining coefficient K_j, annual load average growth rate K_{zzl}, annual maximum load utilization hours T_{max}, and annual maximum load utilization factor δ.

5 Design of Power Source Scheme

5.1 General Provision

5.1.1 The design of power source scheme shall give priority to the basic principle of optimal allocation of energy resources to the greatest extent. The scheme of construction of power sources shall be researched in light of the characteristics of power system under the guideline of macroscopic energy planning, energy and power flow direction as well as networking planning. The design of power sources shall be made by demonstrating the combination scheme and scale of various power sources, such as hydropower, fossil-fired power, nuclear power, gas power, and pumped storage power.

5.1.2 The factors such as dispatchable capacity, power load growth rate, grid structure (including tie-line capacity), reduction of investment and costs, and site conditions shall be taken into account when demonstrating the scale of fossil-fired power plants and the single unit capacity.

5.1.3 Basic requirements for design scheme of power sources

1 Hydropower stations with favorable construction conditions and economic indices shall be given priority.

2 The design of scheme of fossil-fired power sources shall investigate the source and transportation conditions of fuel and the power transmission direction should be in line with the transportation direction of power fuel. When there is no significant difference among economic indices of various schemes, the

construction scheme with higher system safety and stability level should be given priority.

3 On the premises of complying with the overall planning of national nuclear power development, the construction scheme of nuclear stations may be taken into account in the regions where nuclear power station sites are available.

4 The modification of small and medium-sized units and the construction of captive power plants, regional power plants, and cogeneration power plants may be studied and arranged in accordance with the approved feasibility study report.

5 The development of clean energy and renewable energy is encouraged so as to increase energy supply, improve energy structure, and protect environment thereby allowing sustainable development of economy and society.

5.2 Balance of Electric Power and Energy

5.2.1 The balance of electric power and energy primarily aims at defining the required installed capacity of system, peak load regulation capacity, and transmission direction of power sources thereby providing the basis for developing power source scheme, peak load regulation scheme, grid scheme and calculating the required fuel quantity.

5.2.2 In a system in which hydropower units account for a large proportion, two hydrologic years, i.e., a normal flow year and a dry year, shall be selected for the balance. Where necessary, the balance of electric power and energy in wet year and extraordinary dry year shall be checked. The electric power balance shall be made for a dry year and the energy balance for a normal flow year.

5.2.3 The total reserve capacity of a system may be considered to be 15%-20% of maximum power generation load of the system, the lower values being applicable to large scale systems and the higher values to small scale systems. Moreover, the following requirements shall be satisfied:

1 The reserve capacity for load variation shall be 2%-5% of the total load.

2 Emergency reserve shall be 8%-10%, but not less than the capacity of a single unit with the largest capacity in the system.

3 Maintenance reserve shall be determined in accordance with the requirements of relevant regulations and the system conditions, with the reserve being taken as no less than 5% during the initial calculation.

5.2.4 The emergency reserve capacity of the system may be distributed among various power stations in a proportion that corresponds to working capacity they contribute to the system while taking into account the following points:

1 The various types of power sources that contribute to the emergency reserve of the system shall have the corresponding energy or fuel reserve. Specially, a hydropower station contributing to the emergency reserve shall have a capacity (water capacity) reserved in the reservoirs that allows the station to operate under base load for 3d-10d. If the reserve capacity is less than 5% of the capacity of the reservoirs built, the special emergency reserve capacity of the reservoir may be eliminated. The fossil-fired power units contributing to emergency reserve capacity shall operate in the range of economical output for a long time.

2 The hydropower stations that are characterized by favorable regulation performance and close to load centers may assume a larger