2015 国家电网公司专业技术人员电力英语水平考试学习辅导用书

国家电网公司专业技术人员
电力英语水平考试教程

（第二版）

国家电网公司人才交流服务中心　组编

中国电力出版社
CHINA ELECTRIC POWER PRESS

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内 容 提 要

为满足广大专业技术人员电力专业英语学习及考试的需要，国家电网公司人才交流服务中心组织编写了本书，本书共分四部分。第一部分是电力专业英语阅读；第二部分是电力专业英语词汇及术语；第三部分是应试指导，包括题型分析以及各题型举例；第四部分是模拟试题及参考答案。附录中是电力专业英语阅读的标题名录以及商务、技术会话选编。

本书作为专业技术人员参加电力英语水平考试的参考资料，能满足电力英语水平考试考前辅导的需要。同时本书可供广大电力专业技术人员日常查阅，以满足工作需要，提高专业英语水平。

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编　委　会

Preface

前 言

随着科学技术的飞速发展，特别是世界经济全球化的不断加速，电力企业国际交流与合作日益广泛。专业能力强，熟练掌握外语的人士已成为各电力企业最受欢迎的人才。全面提高电力行业专业技术人员的外语水平日渐重要。为此，人才交流服务中心在国家电网公司人力资源部的领导支持下，经多年调查研究，组织电力及相关领域专家结合电力行业实际，反复论证，编写了这本教材，并将其作为专业技术人员电力英语水平考试用书。

为方便广大电力行业各专业的技术人员利用业余时间自学，同时考虑将其作为电力英语水平考试用书，本书在内容编排上力求层次清晰、内容丰富，以帮助考生提高学习效率，化繁为简，少走弯路，最终取得好成绩。

本书共分为四部分：

第一部分是电力专业英语阅读，分为电网类、发电类和综合类三部分，具有较高的知识性和专业性，有助于考生提高专业英语阅读水平。

第二部分是电力专业英语词汇及术语，列出了电力科技英语中常见的词汇及术语，分为电网类和发电类两部分，既可供考生复习备考使用，也可供专业技术人员日常查阅。

第三部分是专业技术人员电力英语水平考试的题型分析及题型举例，使考生对考试有一个初步的认识，了解考试范围，做好充分应试准备。

第四部分是专业技术人员电力英语水平考试模拟试题，并附有参考答案，考生可以通过做题来检验复习的成果，也可借此加深对各题型的认识，增强考试信心。

附录一提供了电力专业英语阅读的标题名录，便于读者查找。附录二则收集了一些常用的商务、技术会话实例。

刘然为本次修订增补了短文及试题，包括：短文判断 4 篇；补全短文 4 篇；阅读理解 8 篇。感谢在编写本书过程中做了大量工作的林肖男、屠志健、麦春生、金家豪、郭骅、邹国荣。北京第二外国语学院齐振海教授对本书的各章节内容进行了认真的审校，保证了本书的权威性。

由于时间仓促，书中难免存在不当之处，还请广大读者批评指正。

编者

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1. Feature of power generation

The simultaneousness of the electric power generation means that the electric power generation, transmission, transformation, distribution and utilization must be performed at the same instant. The electric power can't be stored. Therefore, the balance must be kept at anytime during the electric power generation, distribution, and utilization. The electric power system consists of power plants, transmission networks, distribution networks and the consumer's electric utilization equipment.

The unification of power system equipment means that the generation equipments, transformation equipments, transmission lines, distribution lines and power utilization equipment of a power system form an undivided integer. Without any of them, the power network can not operate normally. The transmission line connecting two power networks is called link line. Some electric power systems are mutually connected by transmission lines to realize power exchange between these systems. Thus, the inter-connected power system is formed. Electric power network is the general name of the transmission network composed of transmission lines and various connected substations. It is simply called the power network.

The features of a modern power network frame are: ① The main network frame is formed by a strong EHV (UHV) system; ② The networks are connected closely to each other; ③ The voltage classes are simplified.

2. Power system

Now most of the electrical energy generated come from the conversion of chemical energy of fossil fuels (coal, petroleum and natural gas), nuclear fission energy and the kinetic energy of water, and the electric power generated are referred to as fossil-fired power, nuclear power and hydro power, respectively.

The voltage is usually transformed to a high level at power plant and then the electric power is transmitted to load center areas via high voltage or extra-high voltage transmission lines. Before electric power is delivered to the electric power consumers (users), there may be more voltage transformations (step-down) at primary substations and local substations. At distribution substations electric power is directly delivered to electric users via feeders at low voltage. Thus the entire system consisting electrically of power stations, substations, power consumers, transmission lines and feeders is called a power system. In functional terms, a power system includes power generation, power transmission, power transformation, power distribution and power utilization.

3. Primary equipment in power system

The equipments in power system can be divided into primary equipments and secondary equipments. The primary equipments of an electric power system refer to the equipments that generate, transmit and distribute the power energy directly. By these equipments the power is sent from power plant to consumers.

The primary equipments in electric power system include: ① equipments for power generation and transformation, such as generators and transformers; ② switchgears for circuit connection or disconnection, such as the circuit breaker, isolating switch, fuse; ③ equipments for limiting fault current and preventing overvoltage, such as reactor and lightning arrester; ④ grounding devices; ⑤ current-carrying conductors; ⑥ current transformer, potential transformer, etc..

4. Secondary equipment in power system

The secondary equipments in power system are the equipments that provide protecting, monitoring, measuring, regulating, controlling primary equipments, the equipments that supply information, working condition for the operator or maintenance persons, and the equipments that send the command signals. The electric circuit connected with the secondary winding of CT or PT is called secondary circuit. The secondary equipment and secondary circuit belong to secondary system.

The voltage and current values in secondary system are: 110V, 220V DC operating voltages, 100V rated voltage of the potential transformer secondary winding and 5A rated current of the current transformer secondary winding. The related parameter values of secondary system after weak electrification are: 24V, 48V, 60V DC operating voltages, 50V rated voltage of PT secondary side, 0.5A rated current of CT secondary side.

5. Load of power system

The loads supplied by power system may be classified into industrial loads and domestic loads. They differ from each other in service requirements and in the facilities needed to supply them. In industrial loads there is high proportion of induction motors. Small industrial loads are supplied by the primary feeders. However, the large industrial loads are usually served from "customer" substations and a very large factory load may require several substations and may be fed from transmission system. Such customer substations require special consideration as to transformer size, connection, location, spare capacity, emergency operating requirements, service continuity, provisions for load growth and system neutral grounding. Domestic loads comprise commercial loads and residential loads. Domestic loads consist largely of lighting, air conditioning and household device loads. Domestic loads are supplied by distribution system.

6. Power network

Power network is that part of the electric power system but the generators and the consumers, including substations, transmission lines and distribution networks. The function of an electric power network is to connect the generating stations with the customers and with the minimum disturbance to transfer this power over transmission lines and distribution network, with the maximum efficiency and reliability to deliver power to consumers at virtually fixed voltage and frequency. Based upon operating voltage, power network can be divided into transmission system and distribution system. Transmission can be classified into high voltage (HV) extra-high voltage (EHV) transmission and ultra-high (UHV) voltage transmission. Voltages above 220kV are usually referred as EHV, and those above 800kV are referred to as UHV. Electric power is transmitted at possible high voltage level either because of transmission distance or because of the amount of transmitted power, or because of their combination.

7. The operation mode of power network

The operation mode of power network refers to the practical working state and connecting mode of the electric parts in electrical main connection. The operation mode of power network can be classified into two categories. One is based on time domain, the other is based on system state. Based on time-domain, operation mode can also be categorized into yearly, seasonal and daily operation modes, and based on system state, operation mode can be categorized into normal accident and special operation modes. The special operation mode refers the operation mode in which the equipments such as main transmission line, large capacity linking transformer etc. are in maintenance, or is the operation modes that have large influence on system operation stability.

The power grid maximum operation mode is the operation mode in which short circuit impedance is the smallest and the short circuit current is greatest when short circuit happens. The short circuit current calculation of maximum operation mode can help: ① to check the stability of the electric equipments selected; ② to check the selectivity and reliability of the protection devices. The function of short circuit current calculation of the minimum operation mode is to check the sensitivity of relaying devices.

8. Neutral grounding modes of power network

The selection of power network neutral grounding mode is related to the factors of power supply reliability, overvoltage, equipment insulation level and to the requirements of protective relaying, etc. Power network neutral grounding modes are as follows: ① The transformer neutral point is directly grounded; ② The transformer neutral point is grounded through an arc quenching coil; ③ The transformer neutral point is grounded through a resistor; ④ The transformer neutral point is not grounded.

The three-phase AC transmission system in which the transformer neutral point is directly grounded is called large current grounding system. In our country, the large current grounding systems are adopted for 110kV and above power networks. The grounding resistance of a large current grounding system is required to be equal to or less than 0.5Ω. The AC transmission system in which the transformer neutral point is not grounded or grounded through an arc quenching coil is called small current grounding system. In our country, the small current grounding system is usually adopted for 3～35kV power networks.

9. Functions of power transmission

The function of power transmission is to send power from power plants to load center or to exchange power between power networks in order to attain the generation-consumption balance or the supply-demand balance between power networks. Power transmission is completed by step-up substations, step-down substations and connected transmission equipment. The transmission line mainly consists of the transmission conductors (cables), poles or towers, insulators, overhead ground wires, and grounding devices. The transmission at high voltage can reduce the line loss and the voltage drop, ensure the power quality, raise the economy of power network operation. The increase of transmission line voltage can not only raise the amount of transmitted power, but also reduce the line loss and line voltage drop, and improve the voltage quality.

10. Power quality

The main indexes of power quality are voltage, frequency and waveform. Voltage quality has influence on the safe and economic operation of power grid. It also has important influence on the safe production of users, the quality of products, the safe operation and life time of electric equipments. The basic conditions ensuring voltage quality are the reactive power balance and reactive power compensation in power system.

11. The power grid frequency in our country

In our country, the standard frequency of power grid is 50Hz. For the power grid with capacity of 3 000MW and above, the allowable frequency deviation is ±0.2Hz; for the power grid with a capacity under 3 000MW, the allowable frequency deviation is ±0.5Hz. In normal condition, frequency should be kept within 50±0.1Hz. In the power grid with capacity of 3 000MW and above, the deviation between electric clock and standard clock (GPS) should not be larger than ±30s; in the power grid with capacity of less than 3 000MW, the electric clock deviation should not be larger than ±60s. How fast the electric clock runs can reflect the variation of power grid frequency, as the motive part of the electric clock is an AC single-phase synchronous motor, the speed of an electric clock can reflect the variation of power system frequency. In the power grid with a capacity of 3 000MW and above, the frequency over or under 50±0.2Hz is called accident frequency. For frequency over or under 50±0.2Hz, the duration should not exceed 60min; For frequency over or under 50±1.0Hz, the duration should not exceed

15min.

12. Regulation of power grid frequency

The purposes of automatic generation control (AGC) are automatically performing real-time regulation of the active power output of the joined generating units, keeping the system frequency or link line power within the required scope under the precondition of optimized generation cost. AGC includes three control modes: ① fixed frequency control mode; ② fixed power exchange control mode; ③ frequency and link line power deviation control mode.

AGC system is a closed loop control system that is composed of main station, AGC software, data transmission channel, remote data receiving terminal, coordination control system of generating unit and related active power measuring devices, etc. The three key sub-systems of AGC are the generation dispatch control system in general dispatch control center, the intermediate data transmission system and the coordination control system of generating units and power plants.

13. Harmonics in power system

The sine wave whose frequency equals the integer multiple of 50Hz fundamental frequency is called harmonics. The nonlinear characteristic of some equipments and loads leads to the distortion of sine wave of power system, which causes harmonics. The main harms to the transformers by harmonics are to make the additional loss and increasing heating, and to cause vibration and noise. Also for power network operation the harmonic will result in the additive damage to the line, because the resonance of inductance and capacitance in the system lead to system accidents and endanger safe operation of power system. In our country the sine wave distortion rate of voltage at the power grid common connection point and the harmonic power supply injecting power grid by the consumer should not exceed the values specified by "Electric Power Quality, Public Power Grid Harmonic".

14. Voltage regulation in power network

The important voltage support nodes in a power system are called voltage pivot nodes, generally they are: ① the high voltage buses of district fossil fired and hydro power plants (the high voltage buses are connected with multiple circuits); ② 500kV or 220kV substation buses with larger short circuit capacity; ③ the power plant buses carrying a large amount of local area load.

The key of voltage regulation is to monitor and control the voltage deviation at voltage pivot nodes, the voltages of which should not exceed the specified scope. Normally, based on the voltage values at the maximum and minimum load, their allowable voltage deviation should be within ±5% of the specified value.

The necessary measure of controlling operation voltage is monitoring the voltage at pivot nodes precisely.

15. Basic conditions of safe and stable operation

The basic requirements of power grid operation are as follows: ① The power grid should operate safely and reliably; ② Power quality is good; ③ The power grid should satisfy the consumer's requirements to the greatest extent; ④ The operation is economic. Safety and stability are the basic conditions of power grid normal operation. Safe operation refers to the condition under which all the electric equipments in the power grid must operate within allowable current, voltage and frequency value and prescribed time limitation. After being disturbed, the condition under which the grid can recover to the original operation state automatically or operate at a new stable state by regulation is called the stable operation.

In power grid operation, the stability of generator synchronous operation, voltage stability and frequency stability are three demands that must be satisfied simultaneously. When generator loses synchronous operation stability, the harmful effect is resulting system oscillation which will lead to improper power supply of the power. The loss of frequency stability will result in system frequency collapse which will lead to power supply interruption of the power system. Losing voltage stability will result in voltage collapse of the power grid and power supply interruption may take place in the affected district.

16. Voltage/ reactive power control

The control of voltage and reactive power are inseparable. The sources of reactive power are electric machines, capacitors and reactors. The reactive power of electric machines is controlled by field excitation. The reactive power of capacitors and reactors can often be controlled by switching. Tap-changing transformers also perform a voltage control function. The present operating procedure is to monitor and control a number of buses' voltage in the system. The dispatcher controls these voltages based on experience, previous operating practices, and off-line load flow studies. He employs the generator bus voltages for control, in addition to the controlled capacitors and reactors.

The implementation of reactive power dispatch for a process computer is feasible. One approach would be to allow the computer to calculate one or more sets of feasible conditions in term of realizable generator bus voltages, switched capacitors and reactors, transformer tap settings and other system constraints that cannot be violated using available information concerning the present state of the system. The dispatcher could then select the condition that is most easily implemented.

17. Power control of power network

Power control of a power network is performed in network control center by means of SCADA system. From the mimic panel and color display device, the dispatchers can directly visualize the real-time information of the grid. Besides, the automation system has also the functions including power summation, load monitoring, post disturbance memory, reporting and printing. In this automation system, the remote terminal units (RTU) are remote power plants and substations.

A powerful application software called energy management system (EMS) is available. Its functions include automatic generation control (AGC), economic dispatching, network topology processing, state estimation, power flow dispatching, and data base management. This power control automation system will realize telemetering, telesignaling, telecontrol and teleregulation in power network.

18. Closed loop operation of power grid

The closed loop operation of power grid refers to the mode of connecting the substations or transformers with the same electrical characteristics into a ring system, making it operate in a single-ring or multi-ring closed loop mode. When the power grids are operated in closed-loop mode, they can transmit and transform electric power each other. They also can support, regulate, and back up each other.

The positive effects of the closed-loop operation of power grid on the power quality include: ① It improves the reliability of power supply or power grid and ensures supplying power to the important consumers; ② The closed-loop operation can reduce power loss and raise the voltage quality.

The closed-loop operation requires the following conditions: ① Phase and phase order should be uniform; ② Various elements in the loop network are not over loaded; ③ The voltages of different buses are within the required scope; ④ The stability is conformed to the specified requirements; ⑤ The relaying and automatic control can satisfy the requirements of closed-loop operation mode.

19. Power system stability

Power system stability can be divided into static-state stability, transient stability, and dynamic stability. After being slightly disturbed, the power system can restore its initial operation state without any non-periodical loss of synchronization. This is called static stability of power system. After being disturbed, through a mechanic-electric transient process the power system transits to a new stable operating state or restore its initial operating state. This is called transient stability of power system. After being disturbed, the power system has no loss of synchronism which may result in the oscillation with ever increasing amplitude. This is called dynamic stability of power system.

The phenomenon that the power angles between generator and system power source or between two power sources of system shows swinging is called power system oscillation. In power system, there are two kinds of oscillations, synchronous oscillation and asynchronous oscillation. The oscillation that keeps synchronism and stable operation of the system is called synchronous oscillation. The oscillation that makes the system lose synchronism and can't operate normally is called asynchronous oscillation. When the power system stability is broken, the generators in the power grid will lose synchronism and operate at an asynchronous state, and the asynchronous oscillation may happen at this time.

20. Reactive power compensation equipment

In a power system, the shortage of reactive power could lower system voltage and power factor, limit the capability of power transmission, and affect safe operation. So, it is necessary to install reactive power compensation equipment. The reactive power compensation of power system is basically in accordance with the principle of gradational, zoned and local equilibrium, and can be regulated with load and voltage to ensure the voltage of main substations satisfying the prescribed requirements under normal circumstances or after accident.

In extra-high voltage long distance transmission, the shunt reactor compensates the capacitance of extra-high voltage transmission lines, and absorbs their reactive power so as to avoid the voltage rise due to too much capacitive power when the lines are light loaded. The shunt capacitor in substation is mainly used to produce reactive power, to decrease the transmission of reactive power and to reduce voltage loss. So the shunt capacitor is basically used for reactive compensation. In a distribution substation, it is mainly used to improve power factor and increase distributed capacity of the distribution network. The series capacitor compensation means that the capacitor is in series connected with transmission line to compensate the inductive impedance and reduce the total reactance of line.

21. Shunt reactor of transmission line

On long transmission lines such as EHV transmission lines, shunt reactors are widely used to reduced high voltages under light load or open line conditions. A shunt reactor is an inductor that is connected line to ground. It consists of one winding insulated for the proper operating voltage. Reactors may be either directly connected to the transmission line or connected on transformer tertiary windings, each location offering specific system benefits. Tertiary reactors can be economically switched as system reactive power requirements and voltage profiles vary. Permanently connected line reactors offer the advantage that they cannot be separated from the compensated line section during line switching operations. Line reactors almost always can reduce line-switching surge magnitudes. The degree of compensation provided by a reactor is usually quantified by the percentage of the line capacitance that is compensated. The percent shunt compensation of EHV lines in service ranges from 0% to 90% with the reactors located in the substations at one or both ends of the line.

22. Switching overvoltage

A sudden change in the configuration of transmission network caused by the operation of a circuit breaker or by the appearance of a fault can cause a rapid surge known as switching overvoltage, which propagates throughout the network. It is these switching overvoltages which in general determine the insulation requirements of transmission lines. Limitating these overvoltages is of extremely importance, because they have an important effect on both the cost of transmission and line failure rate.

These switching overvoltages can occur at both opening and closing of circuit breakers. If non-restriking circuit breakers is not used, it is at the instant of closing, and above all, re-closing of a line which has held a residual charge, that the strongest overvoltages will appear. This switching overvoltage is usually limited by means of circuit breaker closing resistor in 500kV system.

23. Insulation coordination

An area of critical importance in the design of power system is the consideration of the insulation requirements for lines, cables and substations. At first glance, this may appear to be a simple matter once the operating voltage of the system is decided, but unfortunately this is far from so. The transients due to switching, lightning strokes and other causes in the system will cause overltages, and the peak values of these overvoltages can be much in excess of the working voltage.

Insulation coordination is the process of determining the proper lightning impulse insulation level and switching insulation level required in various electrical equipments together with the proper arresters. This process is determined from the known surge characteristics of equipments and the characteristics of arresters. To most engineers, insulation coordination now means: ① the selection of the minimum arrester rating applicable based on system conditions; ② the choice of equipment insulation level that can be protected by the arresters.

Standards have been established covering insulation levels for transformers, breakers and related apparatus, corresponding to each standard voltage level. These are known as “basic impulse insulation levels” (BIL). The switching impulse insulation level (SIL) is the dominant factor for EHV systems.

24. The black start-up of power network

After power interruption caused by accident, the power network gradually extends the recovery scope of power supply by starting up the generating units which is capable of self start-up and finally achieves the goal of completely recovering the operation and power supply of the power networks in the shortest time. This is called the black start-up of power network. When losing external power supply due to the interruption of whole or part of the power network, the capacity of units capable of resetting and recovering the operation of the power network is called black start-up capacity. It’s necessary to predetermine the “black start-up scheme” in order to recover from the accident state quickly and orderly and to reduce losses caused by large scope or whole power network blackout as far as possible. The capacity of uninterrupted power supply in the “black start-up scheme” should be large enough to support the normal operation of such monitoring systems as communication, automation, etc. during black start-up.