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NB

ENERGY INDUSTRY STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

NB/T 11513-2024

Technical code for design of high altitude substation

高海拔变电站设计技术规程

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Foreword

This document was issued on 24 May 2024 by the National Energy Administration of the PRC and takes effect on 24 November 2024.

It is a NB/T standard: recommended rather than compulsory, but it is the text a Chinese reviewer applies when assessing a submission.

It is classified under ICS 29.240, Chinese classification P 62.

This standard was prepared in accordance with the requirements of the plan of the National

Energy Administration for the formulation and revision of industry standards in the energy field. The drafting group carried out extensive investigation and research, carefully summarised practical experience, and prepared this standard on the basis of wide consultation.

The main technical content of this standard is: general provisions; terms; selection of the substation location; the electrical part; the civil part; environmental protection and soil and water conservation; and labour safety and occupational health.

This standard is administered by the National Energy Administration, and the organizations named in it are responsible for the interpretation of the specific technical content.

1 Scope

NB/T 11513-2024 is the Chinese technical code for designing substations at altitudes between 2 000 m and 5 000 m, from 110 kV up to 750 kV. It exists because thin air is a poor insulator and a poor coolant, and above about two kilometres every assumption built into ordinary substation design starts to drift. Air at 4 000 m has roughly 60 percent of the density it has at sea level, so a clearance that holds off a surge at sea level flashes over up high, the corona inception voltage falls and conductors that were quiet begin to hiss and to interfere with radio, transformers shed heat less effectively and have to be derated, and batteries, uninterruptible supplies and diesel generators all lose capacity. The Tibetan plateau adds everything else at once: high seismic intensity, extreme cold, fierce ultraviolet, wind-blown sand, and the highest thunderstorm day counts in the country. This code is what an engineer works from when all of that applies together. It sets the site selection rules, including the protected areas that must be avoided and the treatment of karst ground and seismogenic faults. The electrical part covers the choice of equipment against the combined environment rather than against altitude alone: three-phase transformers up to 330 kV and single-phase above, cooling selected for the real site conditions, temperature rise corrected for altitude under GB 1094.2, low pour point insulating oil below minus 25 degrees, heated or gas-mixture switchgear where the cold would liquefy SF6, ageing-resistant and sand-proof seals, and derated batteries, UPS and diesel sets. For conductors and hardware it fixes the current carrying correction below 4 000 m and requires test above it, and caps the maximum working field strength at 85 percent of the corona inception field strength for both conductors and fittings. The civil part covers architecture and structure, HVAC, water, drainage and fire protection, and - the section that has no counterpart in a lowland code - the oxygen enriched system that makes the control building habitable for the people who work in it. Environmental protection and soil and water conservation, and labour safety and occupational health, close the document, and two appendices give the measured flashover voltages for extra-high-voltage clearances and the required oxygen concentrations. It was issued on 24 May 2024 by the National Energy Administration and took effect on 24 November 2024.

1.0.1 This standard is formulated in order to meet the needs of national and industry standardization work, to achieve the aim of unifying and standardising the technical principles for the design of substations in high altitude areas, and to make the design of substations in high altitude areas comply with the relevant national policies and regulations and meet the requirements of safety and reliability, technical advancement and applicability, economic reasonableness and energy saving and environmental protection.

1.0.2 This standard applies to the design of 110 kV to 750 kV substations at altitudes from 2 000 m to 5 000 m, and specifies principally the design content related to high altitude.

1.0.3 The design of a high altitude substation should adopt new technologies, new equipment, new materials and new processes that are ready for application, in the light of the characteristics of the project and of the environmental and meteorological conditions.

1.0.4 In addition to complying with this standard, the design of a high altitude substation shall also comply with the provisions of the relevant current national standards.

2 Terms

2.0.1 altitude correction factor

The factor by which the coordination withstand voltage is corrected in order to take account of the difference in insulation strength between the mean pressure corresponding to the altitude at which the equipment operates and the standard reference pressure.

2.0.2 supplying oxygen by diffusion system

The complete set of equipment that supplies oxygen to a room by diffusion, through pipework or through terminals.

3 Selection of the substation location

3.0.1 The selection of the substation location shall satisfy the requirements of the power system plan, of the urban or rural master plan, of the land use master plan and of environmental protection, and the best site option shall be determined by a comprehensive technical and economic comparison according to the conditions of transport, terrain and geology, flood control and drainage, water supply and drainage, and power supply.

3.0.2 The site shall avoid the following protected areas and areas where construction is restricted:

1 ecological red line protection areas and permanent basic farmland protection areas;

2 areas of restricted construction around national and provincial level important historical relics and monuments;

3 areas of restricted construction in national and provincial level scenic areas, natural

ecological reserves, important water supply sources and soil and water conservation areas;

4 areas of restricted construction such as airport clearance zones and military installations;

5 areas of restricted construction around important astronomical, meteorological and seismic observation facilities.

3.0.3 The site shall have suitable geological conditions and shall avoid unfavourable geological ground such as serious landslides, debris flows and areas of subsidence. The selection of the site should avoid zones where karst is strongly developed; where this cannot be avoided, a special geological investigation shall be carried out and technical measures shall be taken in accordance with the provisions of the current national standard GB/T 51238 Technical standard for building foundations in karst regions.

3.0.4 Where a seismogenic fault is present at the site, the engineering effect of the fault shall be evaluated in accordance with the provisions of the current national standard GB 50011 Code for seismic design of buildings; the distance by which the site avoids a Holocene active fault shall also comply with the provisions of the current national standards GB 50011 and DL/T 5170 Technical code for geotechnical investigation of substations.

3.0.5 The site should avoid zones threatened by flood and by waterlogging; where the site is located in such a zone, flood control and drainage measures shall be taken. The flood control standard of the site shall comply with the provisions of the current national standard GB 50201 Standard for flood control.

3.0.6 Where the site is located on a hillside or at the foot of a hill, measures shall be taken to prevent mountain torrents and debris flows.

4 Electrical part

4.1 General requirements

4.1.1 The design principles of the main electrical connection of a high altitude substation are the same as those of a substation at conventional altitude. Since high altitude areas may suffer from a weak system network and severe climatic conditions, a connection arrangement of higher reliability may be selected for the substation after full technical justification.

4.1.2 In selecting the type of electrical equipment for a high altitude substation, account shall be taken not only of the effects of the reduced air pressure on external insulation and on heat dissipation, but also of the combined effect of environmental conditions such as high seismic intensity, extreme low temperature, strong ultraviolet radiation and strong wind and sand.

4.1.3 The design of a high altitude substation shall take account of the high number of thunderstorm days that accompanies the terrain and the altitude, and the arrangement of