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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB 50478-2008

**Standard for investigation of geotechnical engineering of
geothermal power plant**

地热电站岩土工程勘察标准

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1 General provisions

- 1.0.1 The document states that it was drawn up to put the geotechnical investigation of geothermal power plants on a regular footing, so that the work is safe and suitable, technically advanced and economically reasonable, and so that quality is assured and the environment protected.
- 1.0.2 It applies to the geotechnical investigation of newly built, extended and reconstructed geothermal power plants.
- 1.0.3 This clause is one of the provisions declared mandatory in the ministerial announcement. Before a geothermal power plant is designed and built, a geotechnical investigation must be carried out following the basic construction procedure.
- 1.0.4 The geotechnical investigation is to follow the requirements of each investigation stage of the project, to reflect the engineering geological conditions, to identify adverse geological actions and geological hazards, to be carried out and analysed with care, and to produce an investigation report whose data are complete and whose assessment is correct.
- 1.0.5 Besides this document, the geotechnical investigation of geothermal power plants is to comply with the relevant current national standards.

2 Terms

- 2.0.1 geothermal power plant - a power plant that generates electricity using the heat energy carried by a geothermal fluid.

2.0.2 geothermal - the natural heat energy that comes from the deep part of the earth crust and is stored in underground rock and in the pores and fissures of rock.

2.0.3 geothermal reinjection - the process of injecting used geothermal fluid or another water source back into, or letting it flow into, the reservoir interval through a reinjection well, in order to keep the reservoir pressure, to use the energy fully and to reduce the pollution caused by discharging geothermal fluid directly.

2.0.4 engineering geological condition - the sum of the conditions directly or indirectly related to the construction works: landform, stratigraphic lithology, geological structure, engineering properties of the soil and rock, hydrogeology, environmental geology and natural construction materials.

2.0.5 geotechnical engineering analysis and evaluation - the collective name for the work of analysing and calculating on the basis of engineering geological mapping, exploration, testing and monitoring, of selecting the geotechnical parameters, of demonstrating the stability and suitability of the site, of the foundation soil and of geotechnical structures, of proposing workable schemes and recommendations for the use, remediation and improvement of the ground, and of predicting and monitoring the geotechnical problems that may arise during construction and operation, together with the corresponding countermeasures, measures and recommendations.

2.0.6 investigation during construction - for building foundations with complex geotechnical conditions or with special service requirements, the investigation needed during construction to add missing information or carried out when the geotechnical conditions found during foundation works do not agree with the investigation report.

3.1 Basic requirements - Basic technical principles

3.1.1 The geotechnical investigation of a geothermal power plant is to identify the adverse geological actions and the geological hazards that affect the siting of the plant, to reflect correctly the engineering geological conditions bearing on design and construction, to analyse and assess the stability of the site, to carry out the geotechnical analysis and evaluation and to put forward sound geotechnical recommendations.

3.1.2 This clause is one of the provisions declared mandatory in the ministerial announcement. A geothermal power plant is strictly forbidden to be sited on ground affected by serious landslides, collapses, debris flows, ground fissures or ground subsidence, or on a Holocene active fault zone.

3.1.3 The geotechnical investigation is to be planned with a technical scheme suited to the depth of work required by the corresponding investigation stage.

3.1.4 The investigation is to use single or combined investigation and testing methods chosen to suit the engineering geological conditions of the site. All original data, records

and test data must be true and reliable.

3.1.5 Where the effect of ground remediation and the construction conditions have to be checked, or where the remediation scheme is to be optimized, a full-scale field test is to be carried out.

3.1.6 Geotechnical analysis is to run through the whole of the investigation, and qualitative and quantitative methods are to be used according to the object analysed.

3.1.7 The classification and identification of soil and rock, engineering geological mapping and survey, exploration, in-situ testing, sampling, laboratory testing and the assessment of the corrosiveness of water and soil are to follow the relevant provisions of the current national standard GB 50021 on geotechnical investigation.

3.1.8 New techniques and new methods are to be taken up in the geotechnical investigation of geothermal power plants.

3.1.9 Field checking is to be carried out during the geotechnical construction works of a geothermal power plant.

3.2 Basic requirements - Classification of building sites

3.2.1 The complexity of a building site may be divided into complex site, moderately complex site and simple site.

3.2.2 A site may be rated complex when any one of six listed conditions is met: complex landform with more than three geomorphological units; many stratigraphic layers, with uneven distribution and widely varying properties of the foundation soil and rock; foundation soil consisting of special soil or rock that is seriously collapsible, saline, contaminated, expansive, frost-heaving or thaw-settling; complex geological structure with strongly developed adverse geological actions; a peak ground acceleration at or above 0.40 g, or ground dangerous for the seismic behaviour of buildings; complex hydrogeological conditions with several groundwater layers affecting the works.

3.2.3 A site may be rated simple when five listed conditions are met together: fairly level terrain with a single geomorphological unit; simple stratigraphic structure with uniform soil and rock properties and no special soil or rock; groundwater buried deep enough not to affect the works; simple geological structure without adverse geological actions; a peak ground acceleration below 0.10 g, or ground favourable for the seismic behaviour of buildings.

3.2.4 Sites outside the conditions listed in 3.2.2 and 3.2.3 may be rated moderately complex.

3.3 Basic requirements - Principles for the division of investigation

stages

3.3.1 The geotechnical investigation of a geothermal power plant is to be carried out in stages, and the division of the investigation stages is to match the design stages. Four stages are named: preliminary feasibility study stage, feasibility study stage, preliminary design stage and construction drawing design stage.

3.3.2 The clause lists the circumstances in which the investigation stages may be adjusted. The first item, the only one on the page read, concerns the geotechnical investigation of extended or reconstructed geothermal power plants, which is to be based on the existing investigation data.

4.1 Investigation at the preliminary feasibility study stage

4.1.1 The investigation at this stage is to give a preliminary assessment of the stability and of the foundation conditions of the candidate sites, to state whether a site is suitable for the plant, and to recommend two or more site schemes that are relatively stable and have better engineering geological conditions.

4.1.2 The investigation should collect seven kinds of material: topographic maps at scales from 1:5000 to 1:50000; regional geological data; regional seismic and seismogeological data; hydrogeological, geotechnical and geological hazard data for the region of the site; geothermal field exploration and geothermal tail water reinjection data; the distribution and exploitation of mineral resources and the distribution and protection grade of antiquities and important fossil groups; local building experience and the current national standards.

4.1.3 The main tasks of the stage are listed: to learn the regional geological structure, the active faults and the seismogeological data of the site area, to determine preliminarily the basic ground motion parameters and to assess preliminarily the tectonic stability of the site area; to survey the adverse geological actions at and near the site, to analyse how damaging they are, to assess preliminarily the stability of the site and to propose avoidance or control measures; to survey the landform, the stratigraphic lithology and the groundwater burial conditions of each site area and to assess preliminarily the type of foundation that may be used; to learn the distribution, exploitation and planning of the geothermal and mineral resources at and near the site; to analyse preliminarily the environmental geological problems of the site and their effect on the works; and, when the peak ground acceleration is at or above 0.10 g, to analyse preliminarily the possibility of seismic liquefaction of saturated sand and saturated silt at the site.

4.1.4 The work of this stage is to consist mainly of collecting material and of field reconnaissance; where necessary, engineering geological survey or mapping, geophysical prospecting and a suitable amount of drilling and pit exploration are to be carried out.

4.1.5 The assessment and recommendation of the site at this stage is to be based on three