



Electric Power Industry Standard of the People's Republic of China

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DL/T 5409.1—2009

Technical Code for Engineering
Investigation of Nuclear Power Plants
Part 1: Seismic Hazard

核电厂工程勘测技术规程
第1部分：地震地质
(英文版)

Date: July 22, 2009

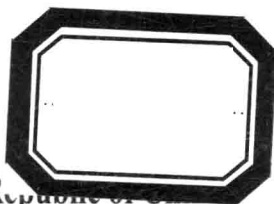
Implementation Date: December 1, 2009

Issued by the National Energy Administration

ICS 27.120

P 64

Record No. J1043—2010



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图书在版编目(CIP)数据

DL/T 5409.1—2009 核电厂工程勘测技术规程. 第1部分, 地震地质 = Technical code for engineering investigation of nuclear power plants part 1: seismic hazard: 英文 / 国家能源局发布. —北京: 中国电力出版社, 2013.5

ISBN 978-7-5123-4480-8

I. ①D… II. ①国… III. ①核电厂—勘测—技术规范—中国—英文 IV. ①TM623-65

中国版本图书馆 CIP 数据核字 (2013) 第 108343 号

中国电力出版社出版

(北京市东城区北京站西街 19 号 100005 <http://www.cepp.sgcc.com.cn>)

北京博图彩色印刷有限公司印刷

*

2013 年 5 月第一版 2013 年 5 月北京第一次印刷

850 毫米×1168 毫米 32 开本 2.375 印张 59 千字

敬告读者

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**Technical Code for Engineering
Investigation of Nuclear Power Plants
Part 1: Seismic Hazard**

Translation sponsored by: China Electric Power Planning &
Engineering Association

Translated by : SUNTHER Consulting Co., Ltd.

Reviewed by : Institute of Geophysics under China Earthquake Administration,
Guangdong Provincial Electric Power Design Institute, and
East China Electric Power Design Institute

CHINA ELECTRIC POWER PRESS

BEIJING, 2013

Foreword

This part is prepared according to the requirements of the *Notice on the Plan for Printing and Distributing Electric Power Industry Standards 2005 Issued by the State Development and Reform Commission* (FGBGY (2005) 739).

DL/T 5409 *Technical Code of Engineering Investigation of Nuclear Power Plants* consists of four parts:

Part 1: Seismic Hazard

Part 2: Geotechnical Engineering

Part 3: Hydrological and Meteorological Survey

Part 4: Surveying

This is part 1 of DL/T 5409.

This part is proposed by China Electricity Council.

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

Chief drafting organizations: the Institute of Geophysics under China Earthquake Administration, Guangdong Provincial Electric Power Design Institute and East China Electric Power Design Institute.

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Any opinions and suggestions proposed during the implementation of this code may be referred to the Standardization Center of China Electricity Council (address: No.1, Lane 2, Baiguang Road, Beijing, 100761).

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1 Scope

This part of DL/T 5409 specifies the contents, details, technical requirements and methods for investigation and evaluation of geology and earthquakes during the stages of pre-feasibility study and feasibility study for sitting of nuclear power plants.

This part is applicable to investigation and evaluation of geology and earthquakes during the stages of pre-feasibility study and feasibility study for siting of nuclear power plants.

2 Normative References

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of DL/T 5409. 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 part of DL/T 5409 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest editions thereof apply to this part.

GB 17741 *Evaluation of Seismic Safety for Engineering Sites*

GB 18306 *Seismic Ground Motion Parameter Zonation Map of China*

GB 50267—1997 *Code for Seismic Design of Nuclear Power Plants*

3 Terms and Definitions

The following terms and definitions apply to this part.

3.0.1

Seismicity

Performance and characteristic in respect of spatial distribution, strength, frequency and their changes over time of an earthquake occurring in a certain regional range.

3.0.2

Seismic structure

Geological structure characteristics in relation to development and occurrence of earthquakes.

3.0.3

Attenuation law of ground motion

Representation of the characteristic and laws of changes in ground motion (ground vibration amplitude, waveform, duration, etc.) as a function of seismic magnitude and distance from epicenter.

3.0.4

Ground motion

Vibration of rock and soil caused by earthquakes.

3.0.5

Ground motion parameter

Physical parameters characterizing the ground motion as a result of earthquakes, including peak values, response spectra and duration.

3.0.6

Probability of exceedance

Probability that a project site may experience a seismic intensity

or ground motion greater than or equal to a given value within a certain period of time.

3.0.7

Design basis ground motion

The ground motion parameters selected for designing a nuclear power plant.

3.0.8

Ultimate safety ground motion (SL-2)

Also referred to as SL-2 level design basis ground motion, corresponding to the ground motion level that will not affect the ultimate safety of a nuclear power plant. The ground motion at this level has a very low annual probability of exceedance during the service life of a nuclear power plant (which is defined to be 1×10^{-4} in GB 50267—1997). It stands for the maximum possible ground motion of a project site that needs to be considered when designing a nuclear power plant.

3.0.9

Operational safety ground motion (SL-1)

Also referred to as SL-1 level design basis ground motion, corresponding to the ground motion level that will not affect the work safety when operating a nuclear power plant. The ground motion at this level has a slightly higher probability of occurrence during the service life of a nuclear power plant (the annual probability of exceedance is defined to be 2×10^{-3} in GB 50267—1997). When a nuclear power plant experiences the ground motion at this level, its normal operation will not be compromised but safety inspection is possibly required.

3.0.10

Time history of ground motion for design

A time history during which a ground motion that satisfies a

combination of conditions (such as the amplitude, frequency spectrum characteristic and duration requirement) is applied to analyze and test the dynamic response for seismic design of structures of a nuclear power plant.

3.0.11

An upper bound estimate of the range of SL-2

Conservative estimation of seismic peak acceleration of bedrocks under the SL-2 level design basis ground motion, which is derived from the preliminary estimation results of the seismic peak acceleration of the bedrocks at a plant site during the pre-feasibility study stage. Generally, this value will not be exceeded during the pre-feasibility study stage.

3.0.12

Capable fault

A fault that may cause obvious displacement on or near the ground surface.

4 General Provisions

4.0.1 This code is prepared to meet the requirements of selection and evaluation of nuclear power plant sites so as to standardize the investigation and evaluation of the geology and earthquakes thereof.

4.0.2 Investigation and evaluation of the geology and earthquakes made during the pre-feasibility study stage is meant to compare multiple candidate plant sites in terms of the seismic and geological conditions so as to provide the basic data in relation to earthquakes for siting of nuclear power plants as well as for the preparation of *the Pre-feasibility Study Report* and *the Project Proposal* for the construction of nuclear power plants.

4.0.3 Investigation and evaluation of the geology and earthquakes made during the feasibility study stage is intended to evaluate the seismic safety of the preferred nuclear power plants' sites, including the evaluation of the site ground motion characteristics and influences of potential ground surface ruptures so as to provide the reference for determining the design basis ground motion parameters used for the preliminary design of nuclear power plants as well as to provide the basic data in relation to the site seismic safety for the preparation of *the Feasibility Study Report* and *the Evaluation Report of the Site Safety* for the construction of nuclear power plants.

4.0.4 Work scope of investigation and evaluation of geology and earthquakes during different stages.

1 Pre-feasibility study:

- 1) Estimate the peak acceleration corresponding to the SL-2 level design basis ground motion at candidate sites.

- 2) Preliminarily identify any capable faults in the vicinity of a plant site.
 - 3) Preliminarily evaluate the potential earthquakes and geological disasters at the plant site.
- 2 Feasibility study:
- 1) Determine the design basis ground motion parameters at a plant site (including the SL-2 level and the SL-1 level).
 - 2) Positively identify any capable faults in the vicinity of the plant site and evaluate the influences of potential ground surface fractures.
 - 3) Evaluate the potential earthquake induced geological disasters at the plant site.

4.0.5 Investigation and evaluation of the geology and earthquakes shall be carried out within three ranges, namely, the region, the nearby area, and the area in the vicinity of a plant site.

1 Region: the range that has influence on evaluating the seismic safety of a plant site and shall extend beyond the periphery of the plant site by no less than 150km. The investigation is mainly intended to obtain the background data of regional geological structures, seismic activities and geodynamics in order to identify and characterize the seismic structures and features that may possibly influence the seismic safety of the plant site.

2 Nearby area: the area centered on a plant site with a radius of no less than 25km. The investigation is intended to obtain the detailed data of geological structures and seismic activities in the area close to the plant site so as to thoroughly identify the activity of critical fractures in the area and if any seismogenic structures exist.

3 Area in the vicinity of a plant site: an area centered on a

plant site with a radius of no less than 5km. The investigation is intended to obtain more precise and detailed geological data in the area directly surrounding the plant site so as to identify the activity of faults located therein, analyze and identify capable faults, and evaluate the influence of any potential ground surface fractures on the plant site.

4.0.6 To ensure the consistency and completeness of the basic data of an entire region, where the region extends beyond the frontier line, one shall collect the geological and seismic data made public by the countries concerned as practical as possible.

4.0.7 The data obtained from different investigation ranges shall be presented consistently and included into the Geographic Information System (GIS). Besides, all the data obtained for the same range and the evaluation and interpretation results shall be presented in the same scale for ease of comparison.

4.0.8 The scales for basic drawings for different investigation ranges are stipulated as follows:

- 1 Region: no less than 1:1 000 000;
- 2 Nearby area: no less than 1:100 000;
- 3 Area in the vicinity of a plant site: no less than 1:25 000.

5 Investigation and Evaluation of Geology and Earthquakes during the Pre-feasibility Study Stage

5.1 General Requirements

5.1.1 The work during this stage is conducted for no less than two candidate plant sites.

5.1.2 Depth requirements of investigation and evaluation contents:

1 Key seismic and geological issues involving the evaluation of the site ground motion level and potential surface rupture influences shall be understood.

2 Investigation and evaluation shall be mainly based on the collection, sorting, and analysis of the existing data. The evaluation results shall be in line with the principle of reasonable conservatism. For seismic and geological problems which are understood but with some uncertainty, they can be dealt with reasonable conservatism based on the existing data.

3 Where the data is not sufficient to complete the evaluation as required during this stage, additional investigation shall be made.

4 For the plant sites located within the zones where seismic peak ground acceleration is less than 0.05 g as shown in GB 18306, Seismic Ground Motion Parameter Zonation Map of China, the relative investigation may be appropriately simplified.

5.2 Investigation of Geological Structures

5.2.1 Investigation of Regional Geological Structure.