

Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 2201.1 (June/1990)

**Design of Nuclear Power Plants against Seismic Events;
Part 1: Principles**

(Auslegung von Kernkraftwerken gegen seismische
Einwirkungen;
Teil 1: Grundsätze)

A previous version of this Safety Standard
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If there is any doubt regarding the information contained in this translation, the German wording shall apply.

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KTA SAFETY STANDARD

June 1990

Design of Nuclear Power Plants against Seismic Events;
Part 1: Principles

KTA 2201.1

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PLEASE NOTE: Only the original German version of this safety standard represents the joint resolution of the 50-member Nuclear Safety Standards Commission (Kerntechnischer Ausschuss, KTA). The German version was made public in Bundesanzeiger No. 194a on October 14, 2000. Copies may be ordered through the Carl Heymanns Verlag KG, Luxemburger Str. 449, 50939 Koeln (Telefax +49-221-94373-603).

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Comments by the editor:

Taking into account the meaning and usage of auxiliary verbs in the German language, in this translation the following agreements are effective:

- shall** indicates a mandatory requirement,
- shall basically** is used in the case of mandatory requirements to which specific exceptions (and only those!) are permitted. It is a requirement of the KTA that these exceptions - other than those in the case of **shall normally** - are specified in the text of the safety standard,
- shall normally** indicates a requirement to which exceptions are allowed. However, the exceptions used, shall be substantiated during the licensing procedure,
- should** indicates a recommendation or an example of good practice,
- may** indicates an acceptable or permissible method within the scope of this safety standard.

Basic Principles

(1) The safety standards of the Nuclear Safety Standards Commission (KTA) have the task of specifying those safety-related requirements which shall be met with regard to precautions to be taken in accordance with the state of science and technology against the damage arising from the construction and operation of the facility (Sec. 7 para. 2 no. 3 Atomic Energy Act), in order to attain the protective goals specified in the Atomic Energy Act and the Radiological Protection Ordinance and further detailed in the "Safety Criteria for Nuclear Power Plants" and the "Guidelines for the Assessment of the Design of Nuclear Power Plants with Pressurized Water Reactor against Incidents pursuant to Sec. 28 para. 3 of the Radiological Protection Ordinance (Incident Guidelines)".

(2) In order to attain these protective goals, Safety Standard KTA 2201.1 - as part of KTA 2201 entitled "Design of Nuclear Power Plants against Seismic Events" - deals with the principles governing the design of nuclear power plants against seismic events. KTA 2201 also contains the following parts:

Part 2: Subsurface Materials (Soil and Rock)

Part 3: Design of Building Structures

Part 4: Requirements to be Met by Methods for the Demonstration of the Aseismic Safety of Mechanical and Electrical Components

Part 5: Seismic Instrumentation

Part 6: Post-Seismic Measures

1 Scope

This safety standard applies to nuclear power plants.

Note:

By analogy, this safety standard may also be used as a basis for all other kinds of nuclear facilities.

2 Specification of the Design Basis Earthquake

(1) The design basis earthquake is the earthquake of maximum intensity at a specific site which, according to scientific knowledge, may occur at the site or within a larger radius of the site (up to approx. 200 km from the site).

Note:

The "intensity" of an earthquake is a measure of its impact on man, structures and the surface of the earth. In this safety standard, the term intensity is defined as the numerical value on the MEDVEDEV-SPONHEUER-KARNIK scale (MSK 1964).

(2) The specification of the design basis earthquake shall include statements of the expected maximum accelerations, the duration of excitation, response spectra, etc. on the basis of seismic assessment taking into account the prevailing geological conditions.

(3) The following principles shall constitute the basis for these assessments:

- a) All historic earthquakes which have affected, or are assumed to have affected, the site shall be listed according to their frequency of occurrence and strength.
- b) Historic earthquakes were characterized by various parameters such as magnitude, intensity and impacts on the ground, on structures and on man. As these parameters are not suited as input data for a design analysis, they shall be replaced by seismic engineering data using adequate relationships in accordance with the state of the art.

- c) Horizontal and vertical accelerations shall be assumed to act simultaneously. The maximum vertical acceleration shall be assumed to be 50% of the maximum horizontal acceleration.
- d) If epicenters or areas of maximum intensity of earthquakes are located in the same tectonic unit as the site; these earthquakes shall be assumed to occur in the vicinity of the site when determining the acceleration at the site.
- e) If epicenters or areas of maximum intensity of earthquakes are located in a tectonic unit other than that of the site, the accelerations at the site shall be determined on the assumption that the epicenters or areas of maximum intensity of these earthquakes are located at a point on the boundary of their tectonic unit which is closest to the site.
- f) The characteristics of ground movements shall be determined on the surface of the soil (free field) of the site.
- g) The maximum acceleration of the design basis earthquake shall be assumed to be $\max a = 0.5 \text{ m/s}^2$ even if $\max a$ was determined to be smaller than 0.5 m/s^2 .
- h) The maximum acceleration of the design basis earthquake shall be assumed to be $\max a = 1.0 \text{ m/s}^2$ if $\max a$ was determined to be between 0.5 m/s^2 and 1.0 m/s^2 .

Note:

The term "maximum acceleration" is defined as

- the rigid body horizontal acceleration of the free field response spectrum (suspension value),
- the maximum value of the resultant of the horizontal acceleration components during the strong-motion phase of the time history of an earthquake (amplitude value).

3 Classification of Plant Components

Taking the safety aspects of the total plant into consideration, plant components shall be divided into two classes for purposes of design against earthquakes:

Class I: Plant components

- which are required for shutting down the reactor safely, for maintaining it in a shutdown condition and for removing the residual heat,
- whose damage or failure can cause or result in an accident involving an impermissible release of radioactive materials,
- which are to prevent an impermissible release of radioactive materials to the environment,

as well as all structures supporting or connecting these plant components.

Class II: All other plant components of the nuclear power plant.

Note:

The term "plant components" also refers to buildings.

4 Loads

(1) For the design of plant components, the following loads shall be distinguished in connection with earthquake loads:

- a) External loads during operation, for example dead weight, permanent loads, live loads, operational loads (considering operating conditions such as scram or refueling), snow loads, wind loads, soil pressure, water pressure, slow-down and start-up forces.
- b) Reactions from constraint during operation, for example forces and moments caused by temperature, creep, shrinkage and support displacements.
- c) Reactions from earthquakes and consequential effects.

d) External loads caused by damage to plant components, which have not been designed against earthquakes, for example pressure build-up, pressure differential, forces from steam or water jets, temperature, missiles and debris.

(2) When combining the loads and reactions listed in para. (1) above, it shall be investigated whether a simultaneous or a sequential occurrence of these loads shall be taken into consideration.

(3) Non-permanent loads which favorably counteract the seismic loads shall not be taken into consideration.

(4) Combinations of loads resulting from earthquakes and earthquake-induced incidents and consequential incidents shall be taken into consideration.

5 Design

(1) All Class I plant components shall be designed in accordance with this safety standard and in such a way that their safety-related functions are preserved during a design basis earthquake. The seismic design of all plant components shall be coordinated.

(2) All Class I plant components shall be designed in such a way that the stresses and/or deformations will remain within admissible limits if the seismic loads of the design basis earthquake occur together with other loads (see Section 4).

Note:

The admissible limits are specified in KTA 2201.3 (being prepared) and KTA 2201.4.

(3) For Class II plant components, no demonstration in accordance with this safety standard is required. However, it shall be demonstrated (in accordance with Section 6) that potential effects from and damage to these plant components will not affect the safety-related functions of any of the Class I plant components.

6 Calculations

6.1 Dynamic Calculation

The calculations required for the design against seismic events shall be carried out by means of such methods (spectral methods, time histories) as will sufficiently account for the earthquake characteristics as well as the behavior of the ground and of the plant components.

6.2 Simplified Calculation

For nuclear power plants at sites for which the maximum accelerations of the design basis earthquake were determined to be less than 1.0 m/s^2 , simplified calculations may be substituted for the dynamic calculation.

6.3 No Calculation Required

If a sufficient degree of safety is either provided for by the design or demonstrated by experimental tests, a calculation need not be carried out.

7 Seismic Instrumentation

If the maximum acceleration of the design basis earthquake was determined to be $\max a_k 1.0 \text{ m/s}^2$ a seismic instrumentation shall be provided in accordance with KTA 2201.5 which will make it possible to determine whether 0.4 times the design values of the design basis earthquake as determined by the calculation have been exceeded. When a value of this inspection level is exceeded, the nuclear power plant shall be subjected to a review.

Note:

The term "design value" is understood as the maximum acceleration determined in the calculation for the location where the acceleration pickup is installed (KTA 2201.5: Seismic Instrumentation).

8 Effects on the Site

8.1 Foundation

Changes to the - possibly improved - ground conditions that may result from an earthquake shall not adversely affect the safety-related function of Class I plant components.

8.2 Environment

Changes in the environment and destruction of engineered facilities such as they may result from an earthquake (e.g. bursting of dams or dikes) shall not adversely affect the safety-related function of Class I plant components.

Appendix

Regulations Referred to in this Safety Standard

(Regulations referred to are only valid in the version cited in this Appendix)

KTA 2201.5 (6/90): Design of Nuclear Power Plants against Seismic Events; Part 5: Seismic Instrumentation