Appendix. D. The Regulatory Guide for Reviewing Seismic Design of Nuclear Power Reactor Facilities (New Guideline, Full Revised at 2006)

Regulatory Guide for Reviewing Seismic Design of Nuclear Power Reactor Facilities

Decision of Atomic Energy Commission

September 1978. Revised by Nuclear Safety Commission on July 20, 1981. Revised by Nuclear Safety Commission on September 19, 2006.

1. Introduction

This guide provides the basis of judgment for seismic design policy adequacy from the standpoints of ensuring seismic safety in Safety Reviews on applications for establishment licenses, including applications for alteration of establishment licenses, of individual light water power reactors.

The Regulatory Guide for Reviewing Seismic Design of Nuclear Power Reactor Facilities decided by the Nuclear Safety Commission (NSC) on July 20, 1981 and revised on March 29, 2001 (Former Guide) was revised based on state-of-the-art evaluation of static seismic forces, etc., by the NSC in July 1981, provided in September 1978 by the Atomic Energy Commission. It was partially revised in March 2001.

The Former Guide has been completely revised to reflect new accumulated seismological and earthquake engineering knowledge and seismic design improvements and developments for nuclear power reactor facilities.

This guide shall be revised to reflect new knowledge and experience as new findings become available.

2. Scope of Application

This guide shall apply to nuclear power reactor facilities (Facilities).

Basic concepts in this guide could be referenced by other nuclear reactor facilities and other nuclear-related facilities.

Application contents not complying with this guide would not necessarily be excluded provided that they reflect technological improvements and developments and could ensure seismic safety beyond the scope of this guide.

3. Basic Policy

A part of Facilities designated as important from the seismic design standpoint shall be designed to bear seismic force exerted by earthquake ground motion and to maintain safety functions postulated appropriately to occur but very rarely in the operation of Facilities from seismological and earthquake engineering standpoints such as geological features, geological structures, and seismicity near the proposed site.

Facilities shall be designed to sufficiently bear design seismic force assumed appropriate for all classification in seismic design from the viewpoint of radiological effects on the environment that could be caused by earthquakes.

Buildings and structures shall be constructed on grounds having sufficient support capacity.

Comments

I. Regarding Basic Policy

(1) Regarding The determination of earthquake ground motion in seismic design

Regarding The determination of earthquake ground motion in seismic design shall be based on the principle that ground motion "that could be postulated appropriately to occur but very rarely during the operation of Facilities and are feared to highly adversely affect Facilities" shall be determined adequately, and that, on the premise of this ground motion, seismic design shall be conducted to avoid risk of serious radiological exposure to the public near Facilities due to external disturbance initiated by an earthquake.

This policy is equivalent to the "basic policy" in the Former Guide that is required in seismic design with the provision that "nuclear power reactor facilities shall maintain seismic integrity against any postulated seismic force assumed so sufficiently that any earthquake would induce significant accidents."

(2) Regarding the existence of "Residual Risk"

From the seismological standpoint, the possibility of the occurrence of stronger earthquake ground motion that exceeds that determined in (1) above cannot be doubted. This means, in determinating seismic design earthquake ground motion, the existence of "Residual Risk"(defined as risk that, by extension of the effect of ground motion that exceeds the determined design ground motion of Facilities, adverse events would occur to Facilities and event in which massive amounts of radioactive materials would be disseminated from Facilities would occur, or results of these events would cause radiological exposure hazardous to the public near facilities).

In Facilities design, appropriate attention shall be paid to the possibility of occurrence of ground motion exceeding the determined one and, recognizing the existence of this "Residual Risk," every effort shall be made to minimize it insofar as practically possible both in the design stage and subsequent stages.

4. Classification of Importance in Seismic Design

The importance in seismic design of Facilities shall be classified as follows from the standpoint of possible radiation impact on the environment caused by earthquakes corresponding to the categories of Facilities:

(1) Classification on Function

Class S

Facilities containing radioactive materials themselves or related directly to Facilities containing radioactive materials, whose loss of function may lead to the dissemination of radioactive materials into the environment, Facilities required to prevent the occurrence of these events and Facilities required to mitigate consequences resulting from the dissemination of radioactive materials in the occurrence of these accidents, and whose influence is highly significant,

Class B

Facilities of the same functional categories as above Class S, but whose influence is relatively small,

Class C

Facilities except for S or Class B, and those required to ensure safety equivalent to general industrial facilities.

(2) Facilities of Classes

Facilities of Classes are as follows based on the above classification of importance in seismic design,

1) Class S Facilities

i) Equipment/piping consisting of the "reactor coolant pressure boundary" (the definition is the same that is in other Regulatory Guides for Reviewing Safety Design of Light Water Nuclear Power Reactor Facilities).

ii) Spent fuel storage pools.

iii) Facilities to add negative reactivity to rapidly shut down the reactor and Facilities to ensure shutdown mode of the reactor.

iv) Facilities to remove decay heat from the reactor core after reactor shutdown.

v) Facilities to remove decay heat from the reactor core after failures in the reactor coolant pressure boundary.

vi) Facilities to prevent the propagation of radioactive materials directly at the pressure barrier in failure accidents in the reactor coolant pressure boundary.

vii) Facilities, except for those in category vi, above, for mitigating the dissemination of radioactive materials into the environment in accidents involving the release of radioactive materials.

2) Class B Facilities

i) Facilities connected directly to the reactor coolant pressure boundary and containing radioactive materials themselves or having the possibility of containing radioactive materials.

ii) Facilities containing radioactive materials, except for those whose "effect of radiological exposure to the public due to their breakage is low enough to compare to the annual exposure limit outside of the peripheral observation area, because of its small inventory of radioactive materials or the difference in the storage system type.

iii) Facilities related to radioactive materials other than radioactive waste and having the possibility, upon breakage, of causing excessive radiological exposure to the public and operational personnel.

iv) Facilities for cooling spent fuel.

v) Facilities, except for those of Class S, for mitigating dissemination of radioactive materials into the environment in accidents involving the release of radioactive materials.

3) Class C Facilities

Those Facilities not belonging to Class S or B above.

5. Determination of Design-Basis Earthquake Ground Motion

Ground motion to be established as the basis of seismic design of Facilities shall be determined adequately as ground motion to be postulated to occur, but very rarely, during the operation of Facilities from the seismological and earthquake engineering standpoint related to geology, geological structure, seismicity, etc., near the proposed site and suspected of making a potentially serious impact on Facilities. (design-basis earthquake ground motion S_S or DBGM S_S).

DBGM S_S shall be determined based on the following principles:

(1) DBGM S_S shall be determined to follow two types of

earthquake ground motions, horizontal and vertical, on the free surface of the base stratum at the proposed site, relating to (2) "site-specific earthquake ground motion whose source is to be identified with the proposed site" and (3) "earthquake ground motion whose source is not to be identified,"

(2) Site-specific earthquake ground motion whose source to be identified with the proposed site shall be determined on the following principles:

1) Taking into account the properties of active faults and the situation of earthquake occurrence past and present near the proposed site, and classifying earthquakes by the pattern of earthquake occurrence, etc., number of earthquakes that are anticipated as severely impacting to the proposed site shall be selected ("investigation earthquakes").
2) The following items shall be taken into account concerning "properties of active faults around the proposed site": in 1), above:
   - i) Active faults considered in seismic design shall be identified as those whose activities since the late Pleistocene epoch cannot be doubted. , the judgment of faults depends on whether fault displacement and deformation exist in the stratum or on the geomorphic surface formed during the last interglacial period.
   - ii) Active faults shall be investigated by integrating geomorphological, geological, and geophysical methods, etc., to clarify the location, shape, and activity of active faults, etc., based on the distance from the proposed site.
3) For any investigation earthquakes selected in 1) above, the following evaluations of earthquake ground motion both 1) with response spectra and ii) using fault models shall be conducted, and DBGM S_S shall be determined from investigation earthquakes.
   In evaluating earthquake ground motion, properties including the regional peculiarities based on the pattern of earthquake occurrence, seismic wave propagation channels, etc., shall be taken into account.
   - i) In the evaluation of earthquake ground motion with response spectra For investigation earthquakes, response spectra shall be appraised by applying appropriate methods and design response spectra shall be evaluated based on these spectra, and earthquake ground motions shall be evaluated taking into account earthquake ground motion properties such as duration and time-dependent change in amplitude-enveloping curves.
   - ii) In the evaluation of earthquake ground motion using fault models For investigation earthquakes, earthquake ground motion shall be evaluated by settling seismic source property parameters appropriately.
4) Uncertainty (dissemination) concerned with the evaluation of DBGM S_S in 3) above shall be considered by applying appropriate methods.

(3) Earthquake ground motion whose source is not identified shall be determined under the following principle:

Design earthquake ground motions shall be determined by collecting observation records near the source obtained from past earthquakes inside the inland earth's crust, whose source cannot be related directly to any active faults, settling response spectra based on records by taking into account ground material properties of the proposed site, and considering earthquake ground motion properties such as duration, time-dependent change of amplitude-enveloping curves, etc.

Comments

II. Regarding DBGM S_S

(1) Regarding DBGM S_S properties

In the Former Guide, for two categories – earthquake ground motion S_1 and earthquake ground motion S_2 – were to be determined. In this revision, however, both of these motions were integrated and attempts made to enhance the selection of investigation earthquakes, evaluation of ground motion, etc. for DBGM S_S.

DBGM S_S is the premise ground motion of seismic design to ensure seismic safety of Facilities and, in determining it, its adequacy shall be checked based on the latest knowledge in specific examinations.

(2) Terminology on DBGM S_S determination is as follows:

1) "Free surface of the base stratum" is defined as the free surface settled hypothetically without any surface layer or structure and as the surface of base stratum postulated to be nearly flat with considerable expanse and without eminent unevenness to plan design-basis earthquake ground motion. "Base stratum" here is defined as a solid foundation for which sear wave velocity Vs exceeds 700m/s and that has not been significantly weathered.
2) "Active faults" are defined as faults that have moved repeatedly in recent geological times and have the possibility of moving in the future.

(3) Regarding principle of DBGM S_S determination

1) In selecting investigation earthquakes the properties of active faults and the situation of earthquake occurrence in the past and at present shall be studied carefully and research results on the distribution of

intermediate, small and fine earthquakes near the proposed site, stress fields, patterns of earthquake occurrence – including shape, movement, and mutual plate interaction – shall be comprehensively studied.

2) Investigation earthquakes shall be selected based on classification considering patterns of earthquake occurrence, etc., as follows:

i) Inside inland earth's crust earthquake

The "inside inland earth's crust earthquake" is defined as one that occurs in the upper crust earthquake generation layer and includes those occurring in rather offshore coasts.

ii) Interplate earthquake

The "interplate earthquake" is defined as one that occurs in the interface plane of two mutually contacting plates.

iii) Inside oceanic plate earthquake

The "inside oceanic plate earthquake" is defined as one that occurs inside a subducting (subducted) oceanic plate, and classified into two types– the "inside subducting oceanic plate earthquake" occurs near the axis of a sea trench or n its rather offshore area, and the "Inside subducted oceanic plate earthquake (slab earthquake)" that occurs in the land area from the vicinity of the sea trench axis.

3) Evaluation using fault models shall be important in earthquakes whose source is near the proposed site and the rupture process is assumed to impact greatly on the evaluation of ground motion.

4) In the consideration of "uncertainty (dissemination) concerned with the determination of DBGM S_S," appropriate methods shall be applied considering the cause of uncertainty (dissemination) and the extent to which it is assumed to impact greatly and directly on planning out DBGM S_S.

5) The principle of the determination of "earthquake ground motion whose source is not identified" implies that, if detailed investigation is sufficient, etc., near the proposed site, it could not be asserted to evaluate all possible earthquakes inside inland earth's crust in advance that could possibly occur near the proposed site, this earthquake shall be considered commonly in all applications despite results of detailed investigation around the proposed site.

DBGM S_S validity determined by putting this principle into practice shall be confirmed specifically in checking on the latest information at each application. Probabilistic evaluation could be referenced as needs arise regarding ground motion near the source generated from a source fault that does not indicate any clear trace on the ground surface.

6) Regarding "site-specific earthquake ground motion whose source to be identified with the proposed site" and "earthquake ground motion whose source is not to be identified," the exceeding probability of earthquakes shall be referenced in each safety examination considering that it is desirable to grasp planed out response spectra of each seismic ground motion corresponding to what extent of the exceedance probability.

7) If investigation and evaluation are implemented in the selection of investigation earthquakes and DBGM S_S determination, existing materials, etc., shall be referenced in considering their accuracy sufficiently. If different results are obtained compared to evaluation results, its reason shall be shown clearly.

8) Regarding the grounds that support Facilities structures and the facilities themselves, if special frequency properties could be found in the seismic response, it shall be reflected in the determination of DBGM S_S as the need arises.

(4) Regarding evaluation of faults assumed to be the source of earthquakes

1) As investigation of active faults is the basis of evaluation of faults assumed as sources of earthquakes, appropriate investigation shall be implemented combining surveys of materials, tectonic geomorphologic examination, the earth's geological surface features, geophysical examinations, etc., based on the distance from the proposed site. Precise, detailed investigations shall be undertaken, especially in areas near the proposed site. The extent of the area near the proposed site shall be decided considering the relationship, etc., to DBGM S_S determined as "Earthquake ground motion whose source is not identified."

2) Active folds, flexures, etc., shall be investigated in 1) above and active faults shall be considered in the evaluation of faults assumed to be sources based on their dispositions.

3) The disposition of faults shall be evaluated grasping the underground structure, etc., depending on the regional situation. Special consideration shall be required if earthquakes are assumed from the disposition of faults in the area where faults are unclear.

4) The earthquake scale shall be determined from the length of the fault, etc., by applying empirical formulas, the scale shall be evaluated considering special features, etc., of empirical formulas.

5) Uncertainty shall be considered in assuming the properties of the source, in case, even by investigation of active faults, sufficient information cannot be obtained to determine source property parameters, including fault shape evaluation. assumed as the source.

6. Principles of Seismic Design

(1) Primary Policy

Facilities shall be designed to fulfill the following primary policies of seismic design for Class categories:

1) Facilities of Class S shall maintain safety functions under seismic force caused by DBGM S_S and shall withstand larger seismic force loading caused by "elastically dynamic design earthquake ground motion Sd" (EDGM S_d) or the static seismic force below.
2) Facilities of Class B shall bear static seismic force shown below, and, as for Facilities having possibility of resonating with earthquake, the influence of it shall be evaluated.
3) Facilities of Class C shall bear the static seismic force shown below.
4) In the items above, the integrity of upper Class Facilities shall not be impaired by damage to lower Class Facilities.

(2) Seismic force calculation

Facilities seismic force for seismic design shall be obtained as shown below.

1) Seismic force caused by DBGM S_S
   Seismic force caused by DBGM S_S shall be calculated by applying DBGM S_S by combining horizontal seismic force with vertical seismic force.
2) Seismic force caused by EDGM S_d
   EDGM S_d shall be established based on DBGM S_S with technological judgment. Seismic force caused by EDGM S_d shall be evaluated by combining horizontal seismic force with vertical seismic force.
3) Static seismic force
   Static seismic force shall be evaluated based on the following:

   i) Buildings and structures
   Horizontal seismic force shall be evaluated by multiplying seismic story shear coefficient C_i by the coefficient corresponding to the importance classification of facilities shown below and multiplying the weight of concerned above story of building.

   Class S: 3.0
   Class B: 1.5
   Class C: 1.0

   C_i of the seismic story shear coefficient shall be obtained by considering vibration properties of buildings and structures, categories of ground, etc. defining standard shear coefficient Co as 0.2.

   For facilities of Class S, both horizontal and vertical seismic force shall act simultaneously in the most adverse direction. Vertical seismic force shall be evaluated with vertical seismic intensity obtained by using seismic intensity 0.3 as a standard, and by considering vibration properties of buildings and structures, categories of ground, etc. The vertical seismic coefficient shall be constant in height.

   ii) Components and piping
   Seismic force of Classes shall be evaluated using seismic intensities obtained by multiplying seismic story shear coefficient C_i in I) above by the coefficient corresponding to the importance classification of Facilities as horizontal seismic intensity, and by increasing horizontal seismic intensity and vertical seismic intensity in I) above by 20%, , horizontal seismic force shall be combined with vertical seismic force simultaneously in the most adverse direction, but vertical seismic force shall be assumed constant in height.

Comments

III. Regarding Design Principles

(1) Regarding the necessity of EDGM S_d establishment

In the Former Guide, design-basis earthquake ground motion was determined classified as earthquake ground motion S_1 and earthquake ground motion S_2 corresponding to the seismic importance classification of buildings, structures, components, and piping, In this revision, DBGM S_S alone shall be required.

In seismic design to ensure seismic safety of Facilities, the basic principle holds that safety functions of seismically important Facilities shall be maintained under seismic force by DBGM S_S.

To confirm maintenance of seismic safety functions of Facilities under DBGM S_S with higher precision, EDGM S_d, closely related to DBGM S_S technically, shall also be required.

(2) Regarding establishment of EDGM S_d

The concept of "bearing seismic force" prescribed in Article 6 in this Guide means that Facilities as a whole are designed in an elastic range for a certain seismic force.

Design in an elastic range means retaining the stress of parts of Facilities within allowable limits by implementing stress analysis treating facilities as the elastic body.

Allowable limits here do not require strict elastic limits but require that Facilities as a whole be retained in an elastic range on the whole even though cases in which Facilities partially exceed the elastic range could be acceptable.

Although Class S Facilities are required "to bear seismic force" by EDEGM S_d, EDGM S_d is established based on technological judgment.

The elastic limits condition involves the impact that earthquake ground motion has on Facilities and the situation of Facilities is evaluated clearly, and ensure to maintaining seismic safety functions as a whole of Facilities under the force by DBGM S_S by confirming that Facilities as a whole retain an elastic limits condition under seismic force by EDEGM S_d.

EDEGM S_d assumes part of the roles that design earthquake ground motion SI of the Former Guide attained in seismic design.

EDGM S_d shall be established by multiplying DBGM S_S by coefficients obtained in technological judgment considering the ratio of input seismic load for safety functional limits and elastic limits for Facilities and their elements. In evaluating the coefficient, the probability of exceedance referenced in the determination of DBGM S_S shall be consulted.

The concrete established value and reason for EDGM S_d establishment shall be sufficiently clarified in specific applications.

The ratio of EDGM S_d and DBGM S_S (S_d/S_S) shall be larger than a certain extent in considering properties required for EDGM S_d, and shall not be less than 0.5 as an targeted value.

EDGM S_d shall be established specifically for elements that make up Facilities depending on the difference in their properties considered in seismic design.

For Class B Facilities, "for Facilities having possibility of resonating with seismic force, the influence shall be evaluated." Earthquake ground motion applied in this evaluation shall be established by multiplying EDGM S_d by 0.5.

(3) Regarding the evaluation of seismic force by DBGM S_S and EDGM S_d

If seismic force by DEGM S_S and EDGM S_d is evaluated based on seismic response analysis, analytical methods shall be selected and analytical consideration shall be settled based on sufficient investigation considering the applicable range of response analysis, applicable limits, etc.

If the "free surface of the base stratum" is very deep compared to the ground level on which Facilities shall be settled, amplification properties of ground motion on the ground level above the free surface of the base stratum shall be investigated

and reflected in the evaluation of seismic response as the need arises,

(4) Regarding static seismic force

Evaluation of static seismic force shall depend on 1) and 2) below.

Regarding buildings and structures, an adequate safety margin for retained horizontal strength of buildings and structures shall be checked to maintain the retained horizontal strength required for the importance of Facilities, and evaluation of the retained horizontal strength required shall comply with 3) below.

1) Horizontal seismic force

i) The datum plane for evaluating horizontal seismic force shall be the ground surface, in principle. If properties such as the constitution of buildings and structures and the relationship to ground surrounding Facilities must be considered, the datum plane shall be provided and reflected in the evaluation.

ii) Horizontal seismic force applied aboveground from the datum plane shall be obtained as the total seismic force acting on the part concerned based on the building height and the structure and be calculated using the following formula:

$$Q_i \quad n \ C_i \ W_i$$

where

Q_i: Horizontal seismic force acting on the part in question,

n: Coefficient based on the importance classification of facilities – earthquake-proof class S: 3.0; earthquake-proof class B: 1.5; earthquake-proof class C: 1.0.

C_i : Seismic story shear coefficient, depending on the following formula:

$$C_i \quad Z \ R_t \ A_i \ C_0$$

where

Z : Zoning factor (to be 1.0, regional difference is not considered),

R_t: Value representing vibration properties of buildings obtained by calculation specified in standards and criteria assumed adequate for safety, "calculation specified in standards and criteria assumed adequate for safety" corresponds to the Building Standard Law, etc.
However, if the value expressing vibration properties is evaluated considering the structural properties of buildings and structures, and response properties and the situation of the ground in the seismic condition is confirmed to fall short of the value calculated in the Building Standard Law, etc., it could be reduced to the value evaluated by this method but equivalent to and not less than 0.7.

A_i: Value representing a vertical distribution of seismic story shear coefficient based on vibration properties of buildings, to be calculated as specified in standards, criteria, and the other appropriate methods such as R_t.

C_0: Standard shear coefficient (0.2),

W_i : Total fixed load and live load supported by the part in question.

iii) Horizontal seismic force acting on parts of buildings and structures under the datum plane shall be evaluated using the following formula:

$$P_k \quad n \quad k \quad W_k$$

where

P_k : Horizontal seismic force acting on the part in question.

n : Coefficient based on importance classification of facilities – earthquake-proof class S: 3.0; earthquake-proof class B: 1.5; earthquake-proof class C: 1.0.

k : Horizontal seismic coefficient found using the following formula:

$$k \quad 0.1 \quad 1 \quad \frac{H}{40} \quad Z$$

where

H : Depth of each under part from the datum plane; 20 (m) at depths of 20 m,

Z : Zoning factor (1.0; the regional difference is not considered).

W_k : Summation of dead load and live load of the part concerned.

If the value is calculated in evaluating vibration properties by considering structural properties of buildings and structures, and response properties and situation of the ground in the seismic condition, it would be the value calculated by this method.

2) Vertical seismic force

Vertical seismic force in the evaluation of static force for earthquake-proof class S Facilities shall be evaluated with vertical seismic intensity using the following formula:

$$C_v \quad R_v \quad 0.3$$

where

C_v; Vertical seismic intensity,

R_v; Value representing vertical vibration properties of the building, 1.0. Based on special investigation or study, if it is confirmed to fall short of 1.0, it shall reduced to a value based on results of investigation or study but equivalent to or not less than 0.7.

3) Retained horizontal strength required

The retained horizontal strength required shall be evaluated specified in standards and criteria accepted as adequate for safety. Standards and criteria accepted as adequate for safety correspond to the Building Standard Law, etc. In the evaluation of retained horizontal strength required, the coefficient regarding the importance classification of facilities multiplied by the seismic story shear coefficient shall be 1.0 in all case of earthquake-proof S, B, class C and standard shear force coefficient Cc used in this case shall be 1.0.

7. Load Combination and Allowable Limit

The basic concept of the combination of loads and allowable limits considered in assessing design principle adequacy for seismic safety is as follows:

(1) Buildings and Structures

1) Earthquake-proof class S buildings and structures

i) Combination with DBGM S_S and allowable limit

Regarding the combination of normal load and operating load with seismic force caused by DBGM S_S, buildings and structures shall have a sufficient deformation acceptability margin – deformation at ultimate strength – as a whole, and the adequate safety margin shall compared to the ultimate strength of buildings and structures.

ii) Combination with EDGM S_d and allowable limit

Regarding stress resulting from combining normal load and operating load imposed with seismic load caused by EDGM S_d or Static seismic force, allowable unit stress specified in standards and criteria assumed adequate for safety shall be established as allowable limits.

2) Earthquake-proof B, class C buildings and structures

Regarding stress resulting from combining normal load and operating load imposed with static seismic forces, allowable unit stress in 1) and ii) above shall be established as allowable limits.

(2) Components and Piping

1) Earthquake-proof class S components and piping

i) Combination with DBGM S_S and allowable limits

Functions of Facilities shall not be affected by the occurrence of excessive deformation, cracks, and failures, even if most parts of structures would reach yield conditions and plastic deformation would occur, with stress due to combined loads occurring in normal operation, unusual transient conditions in operation, and accident conditions with seismic load caused by DBGM S_S.

For active components, etc., acceleration limits, etc, for retaining function shall be established as the allowable limit, confirmed by verification tests, etc., for response acceleration caused by DBGM S_S.

ii) Combination of EDGM S_d with allowable limits

Yield stress or stress with safety equivalent to this shall be established as allowable limits for load resulting from combined loads in normal operation, unusual transient conditions in operation, and accident condition imposed with seismic loads caused by EDGM S_d or static seismic force.

2) Earthquake-proof B, class C components and piping

The yield stress or stress with safety equivalent to this shall be established as allowable limits for loads resulting from combined loads in normal operation.

Comments

IV. Regarding Load Combination and Allowable Limit

The interpretation of the combination of loads and allowable limits shall be based on the following:

(1) Regarding “respective loads that occur in unusual transient operation and accidents,” the load acted on the events which are feared being caused by the earthquake and the loads, even if which are not feared being caused by the earthquake but being caused by events continuing over the long term if they would occur once, shall be considered combined with seismic load.

Even for “a load that occurs in an accident.” considering the relationship between occurrence probability of this accidental event and the duration, and the probability of exceedance of earthquakes, the load caused by this event need not be considered combined with seismic load if the probability that both occur simultaneously is extremely low.

(2) Regarding allowable limits for the combination of buildings and structures with EDGM S_d, etc., although it was required to be established as the “allowable unit stress specified in standards and criteria assumed to be adequate for safety,” these standards and criteria correspond concretely to the Building Standard Law, etc.

(3) “Ultimate strength” in terms regarding combinations of buildings arid structures with DBGM S_S means the bounding maximum bearing load in reaching the condition considered the ultimate condition of structures, where deformation and strain in structures would be increased markedly by adding the load to the structure gradually.

(4) Regarding the allowable limit of components and piping, although the basic principle is required to maintain stress under a “yield stress or equivalent safety situation,” this situation corresponds concretely to that specified in “Technical Standards on Structures, etc., of Nuclear Power Generation Facilities, etc.” prescribed in the Electricity Utilities Industry Law.

8. Consideration of events accompanying earthquakes

Facilities shall be designed regarding events accompanying earthquakes with sufficient consideration of the following terms:

(1) Safety functions of Facilities shall not be significantly affected by the collapses of inclined planes around Facilities that could be anticipated in seismic events.

(2) Safety functions of Facilities shall not be significantly affected by tsunamis anticipated to occur but very rarely during the operation of Facilities.