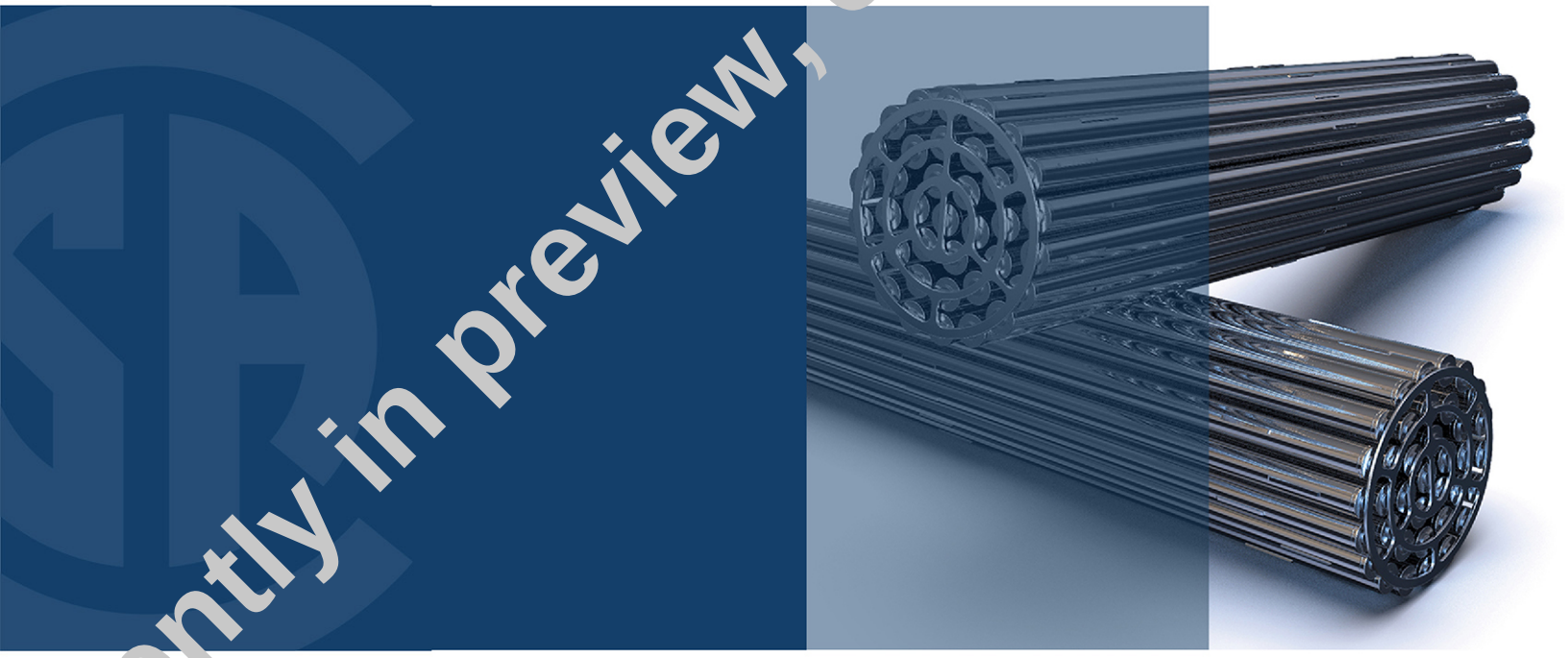
CSA N289.2:21

Ground motion determination for seismic qualification of nuclear power plants



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Ground motion determination for seismic qualification of nuclear power plants

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Contents

Preface

This is the third edition of CSA N289.2, *Ground motion determination for seismic qualification of nuclear power plants*. It supersedes the previous editions, published in 2010 and 1981.

The major changes to this edition include the following:

- Clause 4 has been revised to address microearthquake monitoring and induced seismicity.
- Clause 5 has been revised and restructured to provide more details on and differentiate between seismic source characterization and ground motion models (GMMs), and to address the weights associated with both.
- Clause 6 has been revised to address seismic hazard results for near-fault sites, while considering damage potential of earthquakes, and the development of scenario earthquakes.
- A new Clause 7, on evaluation of seismic hazards considering local site conditions, has been introduced to provide a procedure to account for local conditions and for various sources of uncertainty.
- A new Clause 8, an independent peer review, has been introduced to enhance the confidence level of seismic hazard assessment and evaluations.
- A new informative annex (Annex B) has been introduced for processing earthquake motions recorded at the plant site.
- Another new informative annex (Annex C), a bibliography, has been introduced to include recent references and publications associated with the scope of this Standard.
- This Standard has been aligned with recently published CSA Group standards, CNSC Regulatory Documents, and industry documents.

Standards in the CSA N289 series of Standards are developed in response to a recognition by the utilities and industries concerned with nuclear facilities in Canada of a need for the documentation of standards applicable to the seismic design and qualification of nuclear structures, systems, and components (SSCs) of nuclear power plants. Users of this Standard should recognize that it has the force of law only when adopted by the Canadian Nuclear Safety Commission (CNSC) or the appropriate regulatory body (in countries other than Canada).

The CSA N289 series of Standards consists of five Standards. Some of the objectives of each Standard are summarized as follows:

a) CSA N289.1-18, *General requirements for seismic design and qualification of nuclear power plants*, provides guidelines for identifying structures and systems requiring seismic qualification based on nuclear safety considerations;
b) CSA N289.2:21, *Ground motion determination for seismic qualification of nuclear power plants*, determines the appropriate seismic ground motion parameters for a particular site;
c) CSA N289.3:20, *Design procedures for seismic qualification of nuclear power plants*, provides design requirements, criteria, and methods of analysis for
   i) determining the design response spectra and ground motion time-histories to be used in the analysis;
   ii) establishing design criteria for SSCs, and supports that require seismic qualification; and
   iii) performing seismic analyses, including the effects of the soil-structure interaction;
d) CSA N289.4-12, *Testing procedures for seismic qualification of nuclear power plant structures, systems and components*, provides design requirements and methods for seismic qualification of specific components and systems by testing methods; and

e) CSA N289.5-12, *Seismic instrumentation requirements for nuclear power plants and nuclear facilities*, establishes the requirements for seismic instrumentation and for seismic-related inspection of structures and systems before and after a seismic event.

The CSA N-Series Standards provide an interlinked set of requirements for the management of nuclear facilities and activities. CSA N286 provides overall direction to management to develop and implement sound management practices and controls, while the other CSA Group nuclear Standards provide technical requirements and guidance that support the management system. This Standard works in harmony with CSA N286 and does not duplicate the generic requirements of CSA N286; however, it can provide more specific direction for those requirements.

Users of this Standard are reminded that the design, manufacture, construction, commissioning, operation, and decommissioning of nuclear facilities in Canada are subject to the provisions of the *Nuclear Safety and Control Act* and its Regulations. The Canadian Nuclear Safety Commission (CNSC) can therefore impose additional requirements to those specified in this Standard.

This Standard was prepared by the Subcommittee on Ground Motion Determination for Seismic Qualification of Nuclear Power Plants, under the jurisdiction of the Technical Committee on Seismic Design for Nuclear Power Plants and the Strategic Steering Committee on Nuclear Standards, and has been formally approved by the Technical Committee.

Notes:

1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
3) *This Standard was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*
4) *To submit a request for interpretation of this Standard, please send the following information to inquiries@csagroup.org and include "Request for Interpretation" in the subject line:*
   a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
   b) *provide an explanation of circumstances surrounding the actual field condition; and*
   c) *where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.*

   Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization *and are available on the* Current Standards Activities *page at standardsactivities.csa.ca.*
5) *This Standard is subject to review within five years from the date of publication. Suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line:*
   a) *Standard designation (number);*
   b) *relevant clause, table, and/or figure number;*
   c) *wording of the proposed change; and*
   d) *rationale for the change.*

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0 Introduction

Determination of ground shaking hazard involves the following:

a) geological and seismological investigations performed for site, site vicinity, and region including investigation for secondary earthquake effects;
b) development of seismic hazard models including source characterization;
c) probabilistic evaluation of seismic hazard on reference site condition; and
d) probabilistic evaluation of seismic hazard considering local site conditions.

Uncertainties associated with parameters defining seismic sources and those defining the hazard are typically accounted for.

Note: *Figure 1 is a flowchart outlining the ground motion determination process.*

1 Scope

1.1

This Standard describes the investigations required to obtain the seismological and geological information necessary to determine the seismic ground motion that will be used in seismic qualification of safety-related nuclear power plant structures, systems, and components (SSCs), and the potential for secondary earthquake effects (e.g., tsunami, seiche, volcanism, slope instability, surface faults, surface instability, and dam failures) that can have a direct or indirect effect on plant safety or operation.

Notes:

1) *This Standard establishes the basis for a family of seismic hazard results that can be used as input to CSA N289 Series of Standards. This Standard does not specify*
   a) *ground motion parameters to be used in design;*
   b) *probability level; or*
   c) *degree of confidence to be achieved.*
2) *The investigations specified in this Standard should be updated periodically to reflect gained knowledge and modern requirements. The investigations may be conducted independently or as part of the periodic safety review (refer to REGDOC-2.3.3, CSA N289.1, and CSA N290.18).*

1.2

This Standard was developed for the determination of ground motions for Eastern North American regions of low to moderate seismic hazard, comparable to the levels near Canada's existing nuclear power plants. In regions of higher seismic hazard, the assessment of strong earthquake shaking can be more complex due to near-fault and other effects that are beyond the scope of this Standard. Therefore, while the provisions of this Standard can be applied to any nuclear power plant site, additional provisions might be required for high seismic hazard sites.

Note: *Guidance regarding additional provisions for high seismic hazard sites may be obtained from IAEA* Specific Safety Guide SSG-9*, and relevant codes of other countries.*