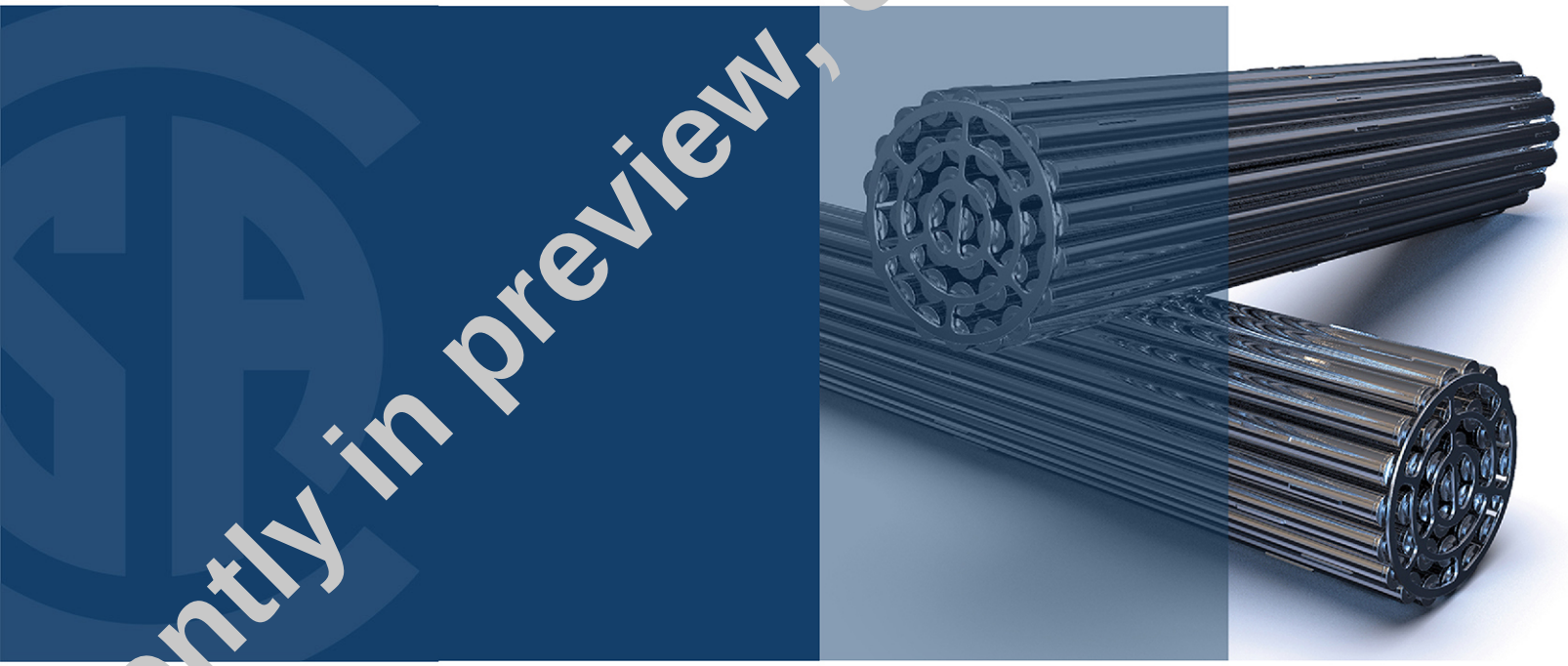
N290.17-17

Probabilistic safety assessment for nuclear power plants



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Preface

This is the first edition of CSA N290.17, *Probabilistic safety assessment for nuclear power plants.*

This Standard provides requirements regarding preparation and maintenance of a probabilistic safety assessment at a water-cooled nuclear power plant. It reflects Canadian regulatory requirements, operating experience of the Canadian nuclear industry, and international good practices, including requirements of the International Atomic Energy Agency, the American Society of Mechanical Engineers (ASME), and the American Nuclear Society (ANS).

Users of this Standard are reminded that the site selection, design, manufacture, construction, installation, commissioning, operation, and decommissioning of nuclear facilities in Canada are subject to the *Nuclear Safety and Control Act* and its *Regulations*. The Canadian Nuclear Safety Commission might impose additional requirements to those specified in this Standard.

The CSA N-Series Standards provide an interlinked set of requirements for the management of nuclear facilities and activities. The CSA N286 Standard 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 might provide more specific direction for those requirements.

This Standard was prepared by the Subcommittee on Probabilistic Safety Assessment for Nuclear Power Plants, under the jurisdiction of the Technical Committee on Reactor Safety and Risk Management 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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Probabilistic safety assessment for nuclear power plants

0 Introduction

0.1 General

A probabilistic safety assessment (PSA) is a systematic assessment of a nuclear power plant (NPP) that considers the frequency, progression, and consequences of unplanned sequences resulting from the failure of systems, structures, and components and/or human actions. It is used in conjunction with other tools and techniques to assess the safety of a water-cooled NPP.

Note: *A PSA is also referred to as a probabilistic risk assessment.*

0.2 Objectives of a PSA

The objectives of a PSA include the following:

a) to provide confidence that the design and operation of a NPP align with the fundamental safety objective of protecting people and the environment from the harmful effects of ionizing radiation;
b) to assess the risk associated with internal hazards and external hazards;
c) to assess the probability of occurrence of fuel damage, including severe core damage;
d) to assess the probability of occurrence, magnitude, timing, and composition of major radioactive releases to the environment;
e) to assess cliff-edge effects;
f) to identify vulnerabilities in the design and operation of a NPP;
g) to assess improvements that could reduce the probabilities or mitigate the consequences of beyond design basis accidents (BDBA), including severe accidents; and
h) to support the management of BDBA, including assessments of the adequacy of emergency operating procedures and the provision of insights into the severe accident management program.

0.3 Reactor technology

The Canadian nuclear industry uses CANDU® reactor technology. However, this Standard is written to be technology neutral, that is, to apply to all water-cooled reactors.

Note: *CANDU (CANada Deuterium Uranium) is a registered trademark of Atomic Energy of Canada Ltd., used under exclusive license by Candu Energy Inc., a member of the SNC-Lavalin Group.*

1 Scope

① 1.1 Reactors and other potential sources

This Standard provides the requirements and guidance for the preparation and maintenance of a PSA at a water-cooled NPP. The radiation sources of concern include both

a) water-cooled power reactors; and
b) other potential sources of radioactive releases to the environment.

Notes:

1) *This Standard may be used to provide guidance for nuclear facilities other than NPPs.*

2) *"Other potential sources" include, for example, wet storage bays and dry used fuel storage facilities.*
3) *Systems that only contain radiation during post-accident conditions (e.g., ECI recovery), are not considered in the identification of radiation sources. The source of radiation of those systems is the reactor, which is considered already as a source.*

1.2 New and existing reactors

This Standard applies to both new and existing water-cooled NPPs.

Notes:

1) *"Existing NPPs" refers to NPPs initially licensed before 2017.*
2) *"New NPPs" refers to NPPs initially licensed after 2016.*
3) *The requirements for a new NPP might be different than the requirements for an existing NPP. This Standard notes where the requirements might be different.*

① 1.3 Single and multi-reactor facilities

This Standard applies to NPPs with one or more water-cooled power reactors.

Notes:

1) *The requirements for a single-reactor NPP might be different than the requirements for a multi-reactor NPP. This Standard notes where the requirements might be different.*
2) *Provisions related to the risk aggregation and whole-site PSA are provided in Clauses 13 and Annex I.*

1.4 Level 1 PSA and Level 2 PSA

This Standard addresses both Level 1 PSA and Level 2 PSA.

① 1.4A Whole-site PSA

This Standard applies to both specific PSAs and whole-site PSAs.

Notes:

1) *A specific PSA might assess only a single hazard for a single source at a NPP. A whole-site PSA assesses all sources and all hazards.*
2) *Some parts of this Standard apply only to specific PSAs. For example, Annexes C to H apply only to specific hazards for power reactors. This Standard notes where requirements apply only to specific PSAs.*

1.5 Malevolent acts

This Standard does not address and does not apply to malevolent acts.

Note: *In Canada, malevolent acts are addressed separately under the CNSC* Nuclear Security Regulations*.*

1.6 Terminology

In this Standard, "shall" is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; "should" is used to express a recommendation or that which is advised but not required; and "may" is used to express an option or that which is permissible within the limits of the standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

