ASME/ANS RA-S-1.1–2024
(Revision of ASME/ANS RA-S-1.1–2022)

Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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FOREWORD

The American Society of Mechanical Engineers (ASME) Board on Nuclear Codes and Standards (BNCS) and American Nuclear Society (ANS) Standards Board have formed a Joint Committee on Nuclear Risk Management (JCNRM) to develop and maintain probabilistic risk assessment (PRA) standards. The JCNRM operates under procedures accredited by the American National Standards Institute (ANSI) as meeting the criteria of consensus procedures for American National Standards. The JCNRM holds two formal meetings per year, and users are invited to participate. Additional information about the JCNRM can be found on its committee page at https://cstools.asme.org/.

The JCNRM is responsible for ensuring that this Standard is maintained and revised, as necessary. This responsibility includes appropriate coordination with and linkage to other standards under development for related risk-informed applications.

In 2002, ASME issued an initial PRA standard, the scope of which was Level 1 and large early release frequency for internal events at-power for light water reactor (LWR) nuclear power plants. In 2003 and 2007, ANS issued two other PRA standards, the scopes of which were external hazards and internal fires at-power for LWR nuclear power plants. In 2008, the three standards were combined into one standard, ASME/ANS RA-S–2008, under the joint auspices of ASME and ANS. A revision, ASME/ANS RA-Sa-2009 [Addendum (a)], was issued in 2009. The JCNRM came into existence after Addendum (a) was issued. A second revision was issued in 2013, ASME/ANS RA-Sb–2013 [Addendum (b)]. This revision was reaffirmed in 2018. A Case was issued in 2017, ASME/ANS RA-S CASE 1, which was an alternative to Part 5 (Seismic PRA). This was then reissued in 2019, ASME/ANS RA-S CASE 1-1, with only minor corrections.

In 2022, ASME/ANS RA-S-1.1-2022 was released and superseded all previous revisions.

ASME/ANS RA-S-1.1-2022 represented a substantial revision of ASME/ANS RA-Sb-2013. The 2022 edition had a significantly larger number of SRs, even though some were removed. However, the intent of the overall Standard remained consistent with the previous version. The following major modifications were among those performed:

- A number of changes were implemented to strengthen the consistency among technical elements that are cross-cutting through different hazards. These changes required, for example, revisiting Supporting Requirements (SRs) associated with screening, uncertainty, human reliability analysis, and documentation. The screening criteria are now consolidated into a single set of screening criteria in Part 1.
- Back references from Part to Part (e.g., from Part 4 to Part 2) were made more consistent, deliberate, and explicit in each Part to facilitate the peer review process.
- Significant lessons learned were gathered in the past few years on hazard PRAs such as high-winds PRAs and external flooding PRAs that previously had less opportunity for being piloted. Such lessons learned were incorporated in clarifications of the intent of the SRs for Part 7 and Part 8.
- Capability Category III was removed across the board on the basis that Capability Category II already envisions refined analysis and realism implemented for the risk-significant elements. Going beyond this, while not discouraged, is not something that needs to be codified in a standard that is supposed to identify the minimum requirements for a technically adequate analysis.
- The 2022 edition of this Standard included a new section in Part 1. Section 1-7 states requirements to assess the technical adequacy of newly developed methods to be used in the plant PRA.
- In previous addenda, Nonmandatory Appendix (NMA) 1-A provided examples of "PRA maintenance" and "PRA upgrades." These subjects are now being addressed by the Pressurized Water Reactor Owners Group (PWROG). The 2022 NMA 1-A provides meanings for the action verbs used in SRs. It is provided as an aid to interpret the intent of the SRs, especially for users for whom English is not the first language.

- Key operating definitions such as the definitions of "PRA upgrade" and "PRA maintenance" were changed. These definitions now agree with the ones presented in PWROG-19027-NP (Rev. 2), "Newly Developed Method Requirements and Peer Review," and endorsed by the U.S. Nuclear Regulatory Commission via Regulatory Guide 1.200 (Rev. 3), "Acceptability of Probabilistic Risk Assessment Results for Risk-Informed Activities." Other definitions have been revisited for clarity.
- Notes and commentaries have been revised to ensure content is still up to date and, for the most part, are removed from the body of this Standard and located in NMAs associated with the individual Parts. This relocation emphasizes the concept that notes and commentaries do not represent formal requirements of this Standard and are provided for information. References are also removed from individual SRs and moved to notes as one way to meet the SRs.
- All peer review requirements have been consolidated into one section in Part 1 to remove inconsistencies and duplicated information from different Parts.
- The clarification regarding the scope of walkdowns documented in JCNRM Inquiry 20-2435 for Addendum B has been included in the NMAs for all walkdown SRs in this Standard. (Inquiry 20-2435 available at https://cstools.asme.org/csconnect/CommitteePages.cfm?Committee=100186782&Action=40886)
- Finally, Part 10 on the Seismic Margin Assessment has been withdrawn from the Standard and is therefore removed.

The current edition, ANSI/ANS RA-S-1-1-2024, presents only minimal editorial modifications and reference corrections from the 2022 edition and further enhances the internal consistency of this Standard. Expanded requirements are only provided for HR-H2 and HR-G3.

This publication, the 2024 edition of the "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," was approved by the ASME BNCS and the ANS Standards Board. ASME/ANS RA-S-1.1-2024 was approved by ANSI on February 29, 2024.

CORRESPONDENCE WITH THE ASME/ANS JOINT COMMITTEE ON NUCLEAR RISK MANAGEMENT

General. ASME codes and standards are developed and maintained by committees with the intent to represent the consensus of concerned interests. Users of ASME codes and standards may correspond with the committees to propose revisions or cases, report errata, or request interpretations. Correspondence for this Standard should be sent to the staff secretary noted on the committee's web page, accessible at https://go.asme.org/JCNRMcommittee.

Revisions and Errata. The committee processes revisions to this Standard on a continuous basis to incorporate changes that appear necessary or desirable as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published in the next edition of the Standard.

In addition, the committee may post errata on the committee web page. Errata become effective on the date posted. Users can register on the committee web page to receive e-mail notifications of posted errata.

This Standard is always open for comment, and the committee welcomes proposals for revisions. Such proposals should be as specific as possible, citing the paragraph number, the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent background information and supporting documentation.

Cases

(a) The most common applications for cases are

(1) to permit early implementation of a revision based on an urgent need

(2) to provide alternative requirements

(3) to allow users to gain experience with alternative or potential additional requirements prior to incorporation directly into the Standard

(4) to permit the use of a new material or process

(b) Users are cautioned that not all jurisdictions or owners automatically accept cases. Cases are not to be considered as approving, recommending, certifying, or endorsing any proprietary or specific design, or as limiting in any way the freedom of manufacturers, constructors, or owners to choose any method of design or any form of construction that conforms to the Standard.

(c) A proposed case shall be written as a question and reply in the same format as existing cases. The proposal shall also include the following information:

(1) a statement of need and background information

(2) the urgency of the case (e.g., the case concerns a project that is underway or imminent)

(3) the Standard and the paragraph, figure, or table number

(4) the editions of the Standard to which the proposed case applies

(d) A case is effective for use when the public review process has been completed and it is approved by the cognizant supervisory board. Approved cases are posted on the committee web page.

Interpretations. Upon request, the committee will issue an interpretation of any requirement of this Standard. An interpretation can be issued only in response to a request submitted through the online Interpretation Submittal Form at https://go.asme.org/InterpretationRequest. Upon submitting the form, the inquirer will receive an automatic e-mail confirming receipt.

ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Standard requirements. If, based on the information submitted, it is the opinion of the committee that the inquirer should seek assistance, the request will be returned with the recommendation that such assistance be obtained. Inquirers can track the status of their requests at https://go.asme.org/Interpretations.

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Committee Meetings. The ASME/ANS JCNRM regularly holds meetings that are open to the public. Persons wishing to attend any meeting should contact the secretary of the committee. Information on future committee meetings can be found on the committee web page at https://go.asme.org/JCNRMcommittee.

ACKNOWLEDGMENTS

The ANS/ASME JCNRM is animated by the passion of more than 200 professionals in the industry, from four continents and spanning the extensive interdisciplinary breadth needed for the development of multihazard, full-scope, comprehensive risk assessments. Their dedication and support continue to sustain the primary role that risk information has in the safe and efficient design, operation, and regulation of nuclear power plants. The members of the JCNRM Working Group on Level 1 LWR have dedicated significant time to the refinement of this Standard.

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Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications

(The following is a roster of the Committee at the time of the approval of this Standard.)

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PART 1
GENERAL REQUIREMENTS FOR A LEVEL 1 PRA, INCLUDING LARGE EARLY RELEASE FREQUENCY

Section 1-1
Introduction

1-1.1 OBJECTIVE

This Standard states the requirements for probabilistic risk assessments (PRAs) used to support risk-informed decisions for commercial light water reactor (LWR) nuclear power plants while at-power.

1-1.2 SCOPE AND APPLICABILITY

This Standard states requirements for a Level 1 PRA of internal and external hazards while at-power for the evaluation of core damage frequency (CDF). In addition, this Standard states requirements for a limited Level 2 PRA sufficient to evaluate large early release frequency (LERF). The only hazards explicitly excluded from the scope are accidents resulting from purposeful human-induced security threats (e.g., sabotage, terrorism). These requirements are written for operating LWR power plants (i.e., plants with designs and features similar to the plants operating when this Standard was published). They may be used for LWR plants under design or construction or for advanced LWRs, but revised or additional requirements may be needed.

1-1.2.1 Treatment of Hazard Groups

This Standard states specific requirements for the following hazard groups:

(a) Internal Events (Part 2)
(b) Internal Floods (Part 3)
(c) Internal Fires (Part 4)
(d) Seismic Events (Part 5)
(e) High Winds (Part 7)
(f) External Floods (Part 8)
(g) Other Hazards (Part 9)

Many of the technical requirements in Part 2 are fundamental requirements for performing a PRA for any hazard group and are therefore relevant to Part 3, Part 4, Part 5, Part 6 (for external hazard screening), Part 7, Part 8, and Part 9 of this Standard. They are included by reference in those requirements that address the development of the plant response to the damage states created by the hazard groups addressed in Part 3, Part 4, Part 5, Part 6, Part 7, Part 8, and Part 9. Their specific allocation to Part 2 is partially a historical artifact of the way this PRA Standard was developed, with the at-power internal-events (including internal floods) requirements being developed first, and those of the remaining hazard groups being developed later. However, it is also a reflection of the fact that a fundamental understanding of the plant response to a reasonably complete set of initiating events (as defined in Section 1-2.2) provides the foundation for modeling the impact of various hazards on the plant. Thus, even though Part 2 is given a title associated with the internal-events hazard group, it is understood that the requirements in this Part are applicable to all the hazard groups within the scope of the PRA.

(The text presented in **blue font** in this Standard comprises hyperlinks to enable efficient access to referenced sections and elements, requirements, notes, references, etc., including hyperlinks to and from HLRs and SRs in the requirements section and appendix.)