ASME/ANS RA-S-1.2–2024
(Revision of Trial Use Standard ASME/ANS RA-S-1.2–2014)

Severe Accident Progression and Radiological Release (Level 2) PRA Standard for Nuclear Power Plant Applications for Light Water Reactors (LWRs)

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

ANS

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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://go.asme.org/JCNRMcommittee.

This Level 2 Standard, ASME/ANS RA-S-1.2-2024, "Severe Accident Progression and Radiological Release (Level 2) PRA Standard for Nuclear Power Plant Applications for Light Water Reactors (LWRs)," was initiated via Project Number ANS-58.24, which ANS later formally requested ANSI to transfer to ASME. In 2015, the JCNRM published ASME/ANS RA-S-1.2-2014, "Severe Accident Progression and Radiological Release (Level 2) PRA Standard for Nuclear Power Plant Applications for Light Water Reactors (LWRs)," which was the trial-use and pilot-application version of this Standard. After a two-year trial-use and pilot-application period, all comments received were collected and resolved by the Level 2 Working Group within the JCNRM. In addition to resolving comments received during the trial-use and pilot-application period, this Standard has been updated to reflect updates that have been made to ASME and JCNRM writers' guides and ballot comments received from the JCNRM. These resulted in a number of changes being made to support self-consistency as well as consistency with other JCNRM standards.

This Standard, ASME/ANS RA-S-1.2-2024, is the current edition of the Level 2 PRA Standard that supersedes all previous versions. 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.

ASME/ANS RA-S-1.2-2024 is a substantial revision of the trial-use and pilot-application Standard, ASME/ANS RA-S-1.2-2014. The following major modifications are among those performed:

- The Level 3 Interface Technical Element has been removed on the basis that the Level 3 trial-use and pilot-application Standard, ASME/ANS RA-S-1.3-2017, "Standard for Radiological Accident Offsite Consequence Analysis (Level 3 PRA) to Support Nuclear Installation Applications," includes all necessary requirements to properly transfer information from a Level 2 PRA.
- Supporting Requirements (SRs) with "No Requirement" for Capability Category I have been redefined in such a way that it is now clear what the requirements are to meet each Capability Category.
- SRs that reference back to the Level 1 Standard, ASME/ANS RA-S-1.1-2024, "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," have been made more consistent, deliberate, and explicit in each Part to facilitate the peer-review process.
- Part 1 has been substantially revised in order to be consistent with the Level 1 Standard and includes revised definitions of significance, new sections dedicated to Configuration Control and Newly Developed Methods, and a Nonmandatory Appendix (NMA) 1-A that defines all action verbs used in this Standard.
- Capability Category III has been 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.
- A number of changes have been implemented to strengthen the consistency among technical elements that are cross-cutting through different standards developed by the JCNRM. These

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changes required, for example, revisiting SRs associated with screening, uncertainty, human reliability analysis, and documentation.

- 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 the NMA 2-A. 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.

This publication, ASME/ANS RA-S-1.2-2024, "Severe Accident Progression and Radiological Release (Level 2) PRA Standard for Nuclear Power Plant Applications for Light Water Reactors (LWRs)," was approved by the ASME BNCS and the ANS Standards Board. ASME/ANS RA-S-1.2-2024 was approved by ANSI on May 31, 2024.

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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 Nuclear Risk Standards and Guidance Subcommittee and the JCNRM Technical Requirements Subcommittee, including reporting working groups, have dedicated significant time to the refinement of this Standard.

A particular debt of gratitude is owed by the JCNRM to Ray Schneider and N. Reed LaBarge, who have been instrumental in leading and coordinating the combined effort needed to update and edit this edition of the Standard, navigating the schedule and challenges of a volunteer organization while maintaining the highest technical rigor.

A number of people have supported the JCNRM for numerous years but retired before seeing the completion of this Standard, for which they provided instrumental help. We acknowledge the efforts of these people and especially the work of Ed Burns, former Level 2 Working Group chair.

We also remember dear friends and significant contributors to this Standard and to the risk-informed technology community that have passed. In memoriam, we acknowledge Mary Drouin, Barry Sloane, and Rupert Weston.

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Severe Accident Progression and Radiological Release (Level 2) PRA Standard for Nuclear Power Plant Applications for Light Water Reactors (LWRs)

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(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

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(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

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PART 1
GENERAL REQUIREMENTS FOR A LEVEL 2 PRA

Section 1-1
Introduction

1-1.1 OBJECTIVE

This Standard states the requirements for Level 2 probabilistic risk assessments (PRAs) for severe accident progression and radiological release for use in supporting risk-informed decisions for commercial light water reactor (LWR) nuclear power plants.

1-1.2 SCOPE AND APPLICABILITY

The scope of this Standard is limited to analyzing the progression of severe accidents from the onset of core damage through radionuclide release to the environment or a determination that a release to the environment will not occur. It includes the analysis of the various phenomena that occur inside the reactor vessel, the containment structure, and neighboring structures that might participate in the radiological release pathway to the environment. This analysis involves carrying the postulated accident sequences from a Level 1 PRA through a probabilistic logic structure such as a containment event tree (CET) (or equivalent) and determining the radionuclide release characteristics (e.g., magnitude and timing) for the various pathways through the CET.

This scope includes accident sequences initiated by internal events, internal hazards, and/or external hazards addressed in ASME/ANS RA-S-1.1-2024 [1-1]. It also includes postulated accident sequences initiated from all modes of reactor operation (at-power, shutdown, and transition states) addressed in ASME/ANS-58.22-2014 (Shutdown PRA Trial Use Standard) [1-2].

The assessment of radiological releases is restricted to radionuclides that originate in fuel located within the reactor pressure vessel. It does not address spent fuel pool radionuclide release nor releases related to purposeful human-induced security threats (e.g., sabotage); this limited scope is consistent with that of ASME/ANS RA-S-1.1-2024 [1-1]. This Standard is limited in scope to single reactor accidents and does not address accident sequences involving releases and interactions among multi-reactor units and fuel storage facilities such as those which occurred at Fukushima Daiichi during March 2011. However, the Standard does provide requirements regarding the status of any other units on site (e.g., status of shared systems inherited from the Level 1 PRA). As such, multi-unit issues are treated to a limited extent, broadly consistent with ASME/ANS RA-S-1.1-2024 [1-1], but combined accident sequences, multiple simultaneous releases from multiple units and radiological sources, and more complex multi-unit issues and interactions are not addressed within this Standard.

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.

(The text presented in blue font in this Standard comprise hyperlinks to enable efficient access to referenced sections and elements, requirements, notes, references, etc.)

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