

ASME/ANS RA-S-2008
(Revision of ASME RA-S-2002)

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

AN AMERICAN NATIONAL STANDARD



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**The American Society of
Mechanical Engineers**



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ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. Interpretations are published on the ASME Web site under the Committee Page at <http://cstools.asme.org>. [Interpretations are also included with each edition and addenda.]

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FOREWORD

The ASME Board on Nuclear Codes and Standards (BNCS) and American Nuclear Society (ANS) Standards Board mutually agreed in 2004 to form a Nuclear Risk Management Coordinating Committee (NRMCC). This committee was chartered to coordinate and harmonize Standards activities related to probabilistic risk assessment (PRA) between the two Standards development organizations (SDO). A key activity resulting from NRMCC was the development of PRA Standards structured around the Levels of PRA (i.e., Level 1, Level 2, Level 3) to be jointly issued by the two societies.

The scope of the initial issue of the ASME RA-S standard included Level 1 and Large Early Release Frequency (LERF) for internal events at power. In parallel with the development of ASME RA-S, ANS was developing companion PRA Standards covering external events, internal fire, and low power and shutdown conditions. These Standards are ANSI/ANS-58.21-2007, ANSI/ANS-58.23-2007, and ANS-58.22 (in development), respectively. ANS-58.22 will be added once it is approved as a revision or addendum. The three existing Standards are assembled together as a revision to ASME RA-S. Consequently, this revision to ASME RA-S is being issued with the revised identity of ASME/ANS RA-S-2008.

A major objective of the combined Standard is to ensure consistency in format, organization, language, and level of detail of the Standard. In assembling the component Standards the following criteria were used:

- (a) the requirements in the Standards would not be revised or modified
- (b) no new requirements would be included
- (c) the numbering scheme of the technical requirements would be preserved
- (d) the common requirements across the Standards would be consolidated into a single place
- (e) the commentary and nonmandatory requirements would be retained

Implementation of the consensus process for this Standard revealed that preserving the exact same requirements from the component Standards created certain technical issues that will need to be addressed in a revision or addendum of ASME/ANS RA-S-2008.

During the development of the ASME RA-S and the ANS companion, titled PRA Standards for Internal Fires, External Events, and Low Power and Shutdown Conditions, concerns were raised by stakeholder organizations and SDOs with respect to stability and consistency in requirements between the Standards. Thus, a key objective of this Standard is to improve consistency and foster stability by enabling future changes to be applied across the various PRA scopes that previously existed as separate Standards. It is anticipated that efficiencies and improvements will result from maintaining, interpreting, and implementing one PRA Standard as opposed to four separate Standards. Additionally, the identification of common processes in general requirements sections for such areas as PRA configuration control, peer review, maintenance versus upgrade, and use in risk-informed applications can now be provided, which further supports consistency and stability. Using a single committee responsible for this Standard provides a single point of response to inquiries and places the expertise necessary to address and coordinate activities in a single cognizant group supported by responsible technical societies. In addition, this Standard is intended to determine the technical adequacy of a PRA such that the PRA can be used in decision making.

The Committee on Nuclear Risk Management (CNRM) operates under procedures accredited by the American National Standards Institute (ANSI) as meeting the criteria of consensus procedures for American National Standards. The initial Standard was approved by the ASME Board on Nuclear Codes and Standards and subsequently approved by ANSI on April 9, 2008.

CNRM is responsible for ensuring that this Standard is maintained and revised as necessary following its original publication. This includes appropriate coordination with and linkage to other Standards under development for related risk-informed applications.

PREPARATION OF TECHNICAL INQUIRIES TO THE COMMITTEE ON NUCLEAR RISK MANAGEMENT

INTRODUCTION

The ASME Committee on Nuclear Risk Management will consider written requests for interpretations and revisions to risk management standards and development of new requirements as dictated by technological development. The Committee's activities in this latter regard are limited strictly to interpretations of the requirements, or to the consideration of revisions to the requirements on the basis of new data or technology. As a matter of published policy, ASME does not approve, certify, rate, or endorse any item, construction, proprietary device, or activity, and accordingly, inquiries requiring such consideration will be returned. Moreover, ASME does not act as a consultant on specific engineering problems or on the general application or understanding of the Standard requirements. If, based on the inquiry information submitted, it is the opinion of the Committee that the inquirer should seek assistance, the inquiry will be returned with the recommendation that such assistance be obtained. All inquiries that do not provide the information needed for the Committee's full understanding will be returned.

INQUIRY FORMAT

Inquiries shall be limited strictly to interpretations of the requirements, or to the consideration of revisions to the present requirements on the basis of new data or technology. Inquiries shall be submitted in the following format:

(a) *Scope.* The inquiry shall involve a single requirement or closely related requirements. An inquiry letter concerning unrelated subjects will be returned.

(b) *Background.* State the purpose of the inquiry, which would be either to obtain an interpretation of a Standard requirement or to propose consideration of a revision to the present requirements. Provide concisely the information needed for the Committee's understanding of the inquiry (with sketches as necessary), being sure to include references to the applicable standard edition, addenda, part, appendix, paragraph, figure, or table.

(c) *Inquiry Structure.* The inquiry shall be stated in a condensed and precise question format, omitting superfluous background information, and, where appropriate, composed in such a way that "yes" or "no" (perhaps with provisos) would be an acceptable reply. This inquiry statement should be technically and editorially correct.

(d) *Proposed Reply.* State what it is believed that the Standard requires. If, in the inquirer's opinion, a revision to the Standard is needed, recommended wording shall be provided.

(e) The inquiry shall be submitted in typewritten form; however, legible, handwritten inquiries will be considered.

(f) The inquiry shall include name, telephone number, and mailing address of the inquirer.

(g) The inquiry shall be submitted to the following address:

Secretary, Committee on Nuclear Risk
Management
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Standard for Level 1/LERF Probabilistic Risk Assessment for Nuclear Power Plant Applications

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PREFACE

ORGANIZATION OF THIS STANDARD

This Standard is organized into Parts as follows:

- Part 1 General Requirements for a Level 1 and large early release frequency (LERF) PRA at-power, including internal events, internal fire, and external events; a Level 1/LERF PRA at low-power and shutdown, including internal and external events (except internal fires)
- Part 2 Technical and peer review requirements for a Level 1 and LERF PRA for at-power, internal events
- Part 3 Technical and peer review requirements for a Level 1 and LERF PRA for at-power, internal fire events
- Part 4 Technical and peer review requirements for a Level 1 and LERF PRA for at-power, external events
- Part 5 Technical and peer review requirements for a Level 1 and LERF PRA for low-power and shutdown, including internal and external events (except internal fires) (to be included at a future date)

Each Part is divided into Sections, and the Sections are labeled sequentially within Parts, as in the following example:

PART 1 LEVEL 1 AND LERF PROBABILISTIC RISK ASSESSMENT GENERAL REQUIREMENTS

- 1-1 Introduction**
- 1-2 Acronyms and Definitions**
- 1-3 Risk Assessment Application Process**
- 1-4 Risk Assessment Technical Requirements**
- 1-5 PRA Configuration Control**
- 1-6 Peer Review**

PART 2 INTERNAL EVENTS AT POWER

- 2-1 Technical Requirements for Internal Events at Power**
- 2-2 Peer Review for Internal Events at Power**

Each Section is subdivided into paragraphs, subparagraphs, and breakdowns, as in the following example:
Paragraph: 1-3.1
Subparagraphs: 1-3.1.2

When paragraphs are used to identify sequential requirements they will be identified by adding a lower-case letter such as (a), (b), (c), etc.

Tables and figures provided in this Standard are identified by the applicable paragraph or subparagraph number for which they apply, with either "Table" or "Fig." and labeled sequentially as follows: 1-3.2.1-1, 1-3.2.1-2, etc. Each table or figure is placed near the text that applies to its use.

References are identified sequentially within the text as bracketed numbers (i.e., [1], [2], etc.). Within tables, references are identified sequentially as Note (1), Note (2), etc. A complete listing of the references, including publishers' information is located in the References section.

When required by context in this Standard, the singular shall be interpreted as the plural, and vice versa.

DESCRIPTION OF SECTIONS WITHIN EACH PART IN THIS STANDARD

The following descriptions of the individual Sections of each Part in this Standard are intended to provide the reader with general information on the scope of coverage and the rationale applied in their development.

PART 1 LEVEL 1 AND LERF PROBABILISTIC RISK ASSESSMENT GENERAL REQUIREMENTS

1-1 Introduction

This Section summarizes the objective, scope, applicability, and contents of the Standard.

1-2 Acronyms and Definitions

This Section identifies and describes unique terms, abbreviations, and acronyms that are used in this Standard.

1-3 Risk Assessment Application Process

This Section describes a process for determining the capability of a PRA to support specific risk-informed applications.

1-4 Risk Assessment Technical Requirements

This Section contains objectives, scope, and general requirements for a PRA to be used in support of risk-informed decision-making.

1-5 PRA Configuration Control

This Section provides requirements for maintaining and upgrading a PRA to be used in support of risk-informed decision-making.

1-6 Peer Review

This Section provides the general requirements for a peer review of a PRA to be used in support of risk-informed decision making.

1-7 References

This Section lists the references cited in Part 1.

1-8 For Further Reading

This Section lists additional references that, although not referenced in this Standard, provide further information about the subject.

PART 2 INTERNAL EVENTS, AT POWER

2-1 Technical Requirements for Internal Events, at Power

This Section contains scope, high level requirements (HLRs), and supporting requirements (SRs) for a Level 1 and LERF internal events, at power PRA to be used in support of risk-informed decision-making.

2-2 Peer Review Requirements for Internal Events, at Power

This Section provides the requirements for a peer review of a Level 1 and LERF internal events, at power PRA to be used in support of risk-informed decision making.

2-3 References

This Section lists the references cited in Part 2.

PART 3 FIRE PRA EVENTS, AT-POWER

3-1 Technical Requirements for Internal Fire Events

This Section contains scope, HLRs, and SRs for a Level 1 and LERF internal fire events PRA to be used in support of risk-informed decision-making.

3-2 Peer Review Requirements for Internal Fire Events

This Section provides the requirements for a peer review of a Level 1 and LERF internal fire events PRA to be used in support of risk-informed decision making.

PART 4 EXTERNAL EVENTS, AT-POWER

4-1 Technical Requirements for External Events

This Section contains scope, HLRs, and SRs for a Level 1 and LERF external events PRA to be used in support of risk-informed decision-making.

4-2 Peer Review Requirements for External Events

This Section provides the requirements for a peer review of a Level 1 and LERF external events PRA to be used in support of risk-informed decision making.

4-3 Documentation Requirements for External Events

This Section provides the requirements documentation of a Level 1 and LERF external events PRA to be used in support of risk-informed decision making.

PART 5 LOW POWER AND SHUTDOWN (TO BE PROVIDED IN A FUTURE PUBLICATION)

5-1 Technical Requirements for Low Power and Shutdown Conditions

This Section contains scope, HLRs, and SRs for a Level 1 and LERF low power and shutdown PRA to be used in support of risk-informed decision-making.

5-2 Peer Review Requirements for Low Power and Shutdown Conditions

This Section provides the requirements for a peer review of a Level 1 and LERF low power and shutdown PRA to be used in support of risk-informed decision making.

USER RESPONSIBILITY

Users of this Standard are cautioned that they are responsible for all technical assumptions inherent in the use of PRA models, computer programs, and analysis performed to meet the requirements of this Standard.

CORRESPONDENCE

Suggestions for improvements to the Standard or inclusion of additional topics shall be sent to the following address:

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ADDENDA SERVICE

This edition of ASME/ANS RA-S-2008 includes an automatic addenda subscription service with no set schedule up to the publication of the next edition. The addenda subscription service includes approved new Sections, revisions to existing Sections, and issued interpretations. The interpretations included as part of the addenda service are not part of this Standard.

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PART 1

LEVEL 1 AND LERF

PROBABILISTIC RISK

ASSESSMENT GENERAL

REQUIREMENTS

Section 1-1

Introduction

1-1.1 OBJECTIVE

This Standard sets forth the requirements for probabilistic risk assessments (PRAs) used to support risk-informed decisions for commercial light water reactor nuclear power plants and prescribes a method for applying these requirements for specific applications.

1-1.2 SCOPE AND APPLICABILITY

This Standard establishes requirements for a Level 1 PRA of internal and external events for all plant operating modes (low power and shutdown modes will be included at a future date). In addition, this Standard establishes requirements for a limited Level 2 PRA sufficient to evaluate large early release frequency (LERF). The only initiating events explicitly excluded from the scope are accidents resulting from purposeful human-induced security threats (e.g., sabotage). This Standard applies to PRAs used to support applications of risk-informed decision-making related to design, licensing, procurement, construction, operation, and maintenance. These requirements are written for operating power plants. They may be used for plants under design or construction, for advanced LWRs, or for other reactor designs, but revised or additional requirements may be needed.

1-1.3 PRA CAPABILITY CATEGORIES

This Standard is intended for a wide range of applications that require a corresponding range of PRA capabilities. Applications vary with respect to which risk metrics are employed, which decision criteria are used, the extent of reliance on the PRA results in supporting a decision, and the degree of resolution required for the factors that determine the risk significance of the proposed changes. To determine the needed capabilities, the application is evaluated by considering PRA technical element attributes, as amplified in para. 1-3.2.2. For example, a proposed change to the maintenance practice for a given component may be evaluated in a particular application. The capabilities of the PRA for those accident sequences involving the failure or unavailability of the component are relevant to such an application, whereas the capabilities of the PRA for other sequences are not as relevant since there are no changes that need to be resolved for these sequences.

The required category of PRA capabilities may vary over different technical elements of the PRA, within a given element, across different accident sequences or classes of accident sequences, initiating events, basic events, hazard groups, and end states, depending on the application. Although the range of capabilities required for each portion of the PRA to support an application falls on a continuum, three Capability Categories are defined in this Standard so that requirements can be developed and presented in a manageable way.