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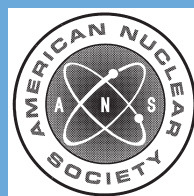
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**external-events
PRA methodology**

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External-Events PRA
Methodology**

Secretariat
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Foreword

This standard sets forth requirements for external-events probabilistic risk assessments (PRAs) and related analysis methodologies that can be used to support risk-informed decisions for commercial nuclear power plants. This standard also prescribes a method for applying these requirements for specific applications.

This standard is intended to be used together with other PRA standards that cover different aspects of PRA scope. Specifically, this standard is intended to be used directly with the PRA standard developed by the American Society of Mechanical Engineers (ASME) (“Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications,” ASME-RA-S-2002), which covers an “internal-events PRA” for a commercial nuclear power plant operating at nominal full power. Similarly, this standard is intended to be used with two other standards when those, now under development, are available: the American Nuclear Society (ANS) PRA-methodology standard covering low-power/shutdown operations and the ANS PRA-methodology standard covering accidents initiated by internal fires.

External events covered within this standard’s scope include both natural external events (e.g., earthquakes, high winds, and external flooding) and human-made external events (e.g., airplane crashes, explosions at nearby industrial facilities, and impacts from nearby transportation activities).

The scope of a PRA covered by this standard is limited to analyzing accident sequences initiated by external events that might occur while a nuclear power plant is at nominal full power. It is further limited to requirements for (a) a Level 1 analysis of the core damage frequency and (b) a limited Level 2 analysis sufficient to evaluate the large early release frequency. The scope of a seismic margin assessment (SMA) covered by this standard is limited to analyzing nuclear power plant seismic capacities according to either the so-called Electric Power Research Institute method or the so-called U.S. Nuclear Regulatory Commission (NRC) method, the guidance documents for both of which are referred to and heavily relied on in this standard itself.

In contrast, the scope of ASME-RA-S-2002 covers internal plant initiators (except internal fires) that might occur while the nuclear power plant is at nominal full power. Accidents initiated by internal flooding are explicitly included in ASME-RA-S-2002, as are accidents initiated by a loss of off-site power (LOSP), unless the LOSP is due to one of the external events covered herein that also causes other important damage to the plant, in which case the LOSP is within the scope here. Therefore, this standard and ASME-RA-S-2002, when used together, cover all potential accident initiators arising at nominal full power, except internal fires. The only initiators explicitly excluded are accidents resulting from purposeful human-induced security threats (e.g., sabotage).

The scope of this standard includes the widely used SMA methodology. SMA methods employ many of the same tools as a seismic PRA. SMA methods can be used, as appropriate, for selected risk-informed applications. The scope also includes not only traditional PRA analyses, which are intended to be realistic, but also screening analyses and demonstrably conservative or bounding approaches that use aspects of PRA methodology but are not full-scope PRAs themselves. Many risk-informed applications can and do use such analyses.

The types of risk-informed PRA applications contemplated under this standard are very broad and include applications related to design, procurement, construction, licensing, operation, and maintenance. Both regulatory risk-informed applications involving the NRC and applications not involving those regulations are contemplated. While the NRC does not require the use of this standard for

any specific risk-informed applications, its use is expected to be common in such applications. In this regard, this standard's approach is intended to be identical to that used in the closely related ASME-RA-S-2002, so the approach and supporting logic of ASME-RA-S-2002 are relied upon heavily in this standard's guidance in this area.

In the last 3 years since the publication of the Standard, there have been additional comments from the NRC and the nuclear industry. Further, the ASME Standard for internal events PRA has been revised. ANS-58.21 has been revised to incorporate these comments and changes.

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This standard was processed and approved for submittal to ANSI by the Risk Informed Standards Committee (RISC) on ANSI/ANS-58.21, "External-Events PRA Methodology." Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the RISC Committee had the following members:

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External-Events PRA Methodology

1 Introduction

1.1 Objectives

The objectives of this standard¹⁾ are to set forth requirements for external-events probabilistic risk assessments (PRAs) used to support risk-informed decisions for commercial light water reactor nuclear power plants and to prescribe a method for applying these requirements for specific applications. Additional or revised requirements may be needed for other reactor designs.

1.2 Coordination with Other Probabilistic Risk Assessment Standards

This standard is intended to be used together with other PRA standards that cover different aspects of PRA scope. Specifically, this standard is intended to be used directly with the PRA standard developed by the American Society of Mechanical Engineers (ASME), “Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications,” ASME-RA-S-2002²⁾ [1],³⁾ which covers an “internal-events PRA” for a commercial nuclear power plant operating at nominal full power. [See 1.3 for a more complete description of the ASME scope.⁴⁾] Similarly, this standard is intended to be used with the American Nuclear Society (ANS) standard covering low-power/shutdown operations when that standard, now under development, is available. However, additions and modifications to the technical requirements will be necessary to cover PRAs for accidents initiated by external events during low-power/shutdown operation.

This standard is also intended to be used together with Standard BSR/ANS-2.27, “Guidelines for Investigations of Nuclear Facility Sites for Seismic Hazard Analysis” [2], and Standard BSR/ANS-2.29, “Probabilistic Seismic Hazards Analysis” [3], when those standards, now in draft form, are completed. BSR/ANS-2.27 and

BSR/ANS-2.29, which will have more detail than this standard in certain technical areas, are referred to in the appropriate places in this standard that cover requirements related to hazard analysis.

1.3 Scope

The scope of a PRA covered by this standard is limited to analyzing accident sequences initiated by external events that might occur while a nuclear power plant is at nominal full power. It is further limited to requirements for (a) a Level 1 analysis of the core damage frequency (CDF) and (b) a limited Level 2 analysis sufficient to evaluate the large early release frequency (LERF). The scope of a seismic margin assessment (SMA) covered by this standard is limited to analyzing nuclear power plant seismic capacities according to either the so-called Electric Power Research Institute (EPRI) method (“EPRI Method”) [4] or the so-called U.S. Nuclear Regulatory Commission (NRC) method (“NRC Method”) [5].

Although both seismic PRA and SMA are intended to support risk-informed applications, the distinction between them regarding their applicability to develop risk insights needs to be clearly understood. The SMA is a deterministic methodology, and in this context, a well-executed SMA can provide qualitative, and limited, risk insights that could be used to support an intended application. However, for situations where detailed quantitative risk insights are necessary, a seismic PRA is needed.

External events covered within this standard’s scope include both natural external events (e.g., earthquakes, high winds, and external flooding) and human-made external events (e.g., airplane crashes, explosions at nearby industrial facilities, and impacts from nearby transportation activities). Appendix A contains an extensive list of most of the external events generally

¹⁾ The current standard, ANSI/ANS-58.21-2007, is herein referred to as “this standard.”

²⁾ The ASME standard is herein referred to as “ASME-RA-S-2002.”

³⁾ Numbers in brackets refer to corresponding numbers in Section 8, “References.”

⁴⁾ All section numbers refer to sections in this standard unless specifically stated otherwise.