ANS/ASME-58.22-2014

Requirements for Low Power and Shutdown Probabilistic Risk Assessment

TRIAL USE AND PILOT APPLICATION

Publication of this standard for trial use has been approved by The American Society of Mechanical Engineers and the American Nuclear Society. Distribution of this standard for trial use and comment shall not continue beyond 36 months from the date of publication, unless this period is extended by action of the Joint Committee on Nuclear Risk Management. It is expected that following this 36-month period, this draft standard, revised as necessary, will be submitted to the American National Standards Institute (ANSI) for approval as an American National Standard. A public review in accordance with established ANSI procedures is required at the end of the trial-use period and before a standard for trial use may be submitted to ANSI for approval as an American National Standard. This trial-use standard is not an American National Standard.

Comments and suggestions for revision should be submitted to:

Secretary, Joint Committee on Nuclear Risk Management
The American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990

The American Society of Mechanical Engineers

ANS

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NOTE: The trial use period has been extended by the ASME/ANS Joint Committee on Nuclear Risk Management to December 31, 2019.

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(This Foreword is not a part of "Requirements for Low Power and Shutdown Probabilistic Risk Assessment," ANS/ASME-58.22-2014.)

FOREWORD

The American Society of Mechanical Engineers (ASME) Board on Nuclear Codes and Standards (BNCS) and the American Nuclear Society (ANS) Standards Board mutually agreed in 2004 to form the Nuclear Risk Management Coordinating Committee (NRMCC). The NRMCC was chartered to coordinate and harmonize standards activities related to probabilistic risk assessment (PRA) between ASME and ANS. A key activity resulting from NRMCC was the development of PRA standards structured around the Levels of PRA (i.e., Level 1, Level 2, and Level 3) to be jointly issued by ASME and ANS. In 2011, ASME and ANS decided to combine their respective PRA standards committees to form the ASME/ANS Joint Committee on Nuclear Risk Management (JCNRM).

Publication for Trial Use

Publication of this standard for trial use has been approved by the JCNRM as a stand-alone standard. However, the writing of this standard began under the ANS Risk Informed Standards Committee; hence, ANS writing guidance has been followed. The current plan is for this standard, once approved as an ANSI standard, to be incorporated into RA-S-1.1, the "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications."

The previous drafts of this standard have gone through several rounds of reviews by the JCNRM members, and all comments have been addressed in this version published for trial use. While the comments were resolved, there are remaining technical issues that are best resolved by testing this standard against different actual applications. This will ensure that the lessons learned from pilot applications are adequately addressed in this standard. Examples of pilot applications might include a gap analysis for an existing Low Power and Shutdown (LPSD) PRA model, or the development of new LPSD PRA models according to this standard. The JCNRM encourages any form of trial use of this proposed standard and requests feedback from trial users.

The project team and the readiness review team of this standard have identified the following potential issues, and it is hoped that these can be addressed in the trial use applications. Both the project team and the consensus ballot readiness review team believe that any of the requirements included in the LPSD Standard can be addressed with existing methods and data or supplemented by modest research of existing industry experience data. Nevertheless, the project team believes this should be verified during the trial use applications.

Potential Low Power and Shutdown PRA Standard Issues for Which Trial Use Feedback Is Desired	
Potential Issue	**Background and Project Team Assessment**
1. Whether the required number of plant operating states (POS) needed to satisfy the requirements of the standard are so excessive as to make the analysis impractical.	This issue was identified by comments on earlier drafts. The LPSD Standard has chosen to define specific attributes whose collective states make up the definition of each POS. These attributes were selected by experienced analysts that have performed LPSD analyses on real plants. Owner's groups have also developed guidance for developing LPSD models in which specific POSs are defined as examples. A non-mandatory appendix has been added to the standard to describe considerations in developing POSs. The project team does not believe the requirements will pose an excessive analysis burden.
2. Whether POSs are suitable when defined at a level of detail consistent with plant configurations sufficient to evaluate time-dependent risk metrics, as opposed to just considering the attributes listed in LPOS-A3.	This issue was identified by a commenter who wanted the flexibility to declare each plant configuration as a POS. This standard published for trial use allows either the use of plant configurations to define the POSs or the definition of POSs by collections of states of plant attributes to be used. POSs are widely used in existing PRA models for shutdown events.
3. Whether the requirements for at-initiator human actions analysis are reasonable and effective (at-initiator actions are human failure events that cause an initiating event; see Section 1.2.2).	This issue was first identified by a writing group member concerned about the possible omission of such considerations from earlier drafts of the standard. More recent commenters have expressed concerns that requirements added in response to this issue are too onerous. The project team believes that the available industry data for initiating events during shutdown conditions are adequate to identify the HRA contribution, although additional research to focus on this question would benefit this process. The project team believes that the main concern here is to identify and account for potential dependencies between the initial error and subsequent actions called on in response to the initial error. Such dependencies may be identified and considered to some degree by a review of operating experience to identify the conditions in which events originate. This conclusion limits the scope of the response needed to address the standard's requirements. Further research expanding the set of events reviewed would require a focused effort.
4. Whether the methods for human error probability (HEP) quantification are suitable for shutdown conditions.	This issue was first identified by a commenter concerned about the applicability of HRA methods developed for full power plant operating conditions to LPSD conditions where different sets of procedures apply. The project team notes that the methods developed for full power conditions are not restricted to full power, nor were they specifically calibrated to those conditions. This comment made more sense in past years when the procedures for shutdown conditions were less developed; however, at present, such procedures are better developed. Furthermore, The project team believes that the use of existing HRA methods for sequences initiating from full power conditions are also applicable for shutdown conditions.

Potential Low Power and Shutdown PRA Standard Issues for Which Trial Use Feedback Is Desired	
Potential Issue	**Background and Project Team Assessment**
5. Whether the approach to external hazards adequately captures the needed requirements for LPSD PRA for those hazards, for which only a few applications exist in the literature.	This is a general question that recognizes that plant conditions change during the different stages of a low power and shutdown evolution. The LPSD Standard acknowledged this in purposely excluding requirements for assessing internal fire hazard events as part of this version of the LPSD Standard. For other external event hazards, the standard states that these changes should be considered on a POS-by-POS basis. The project team believes that this set of requirements is appropriate and can be applied despite limited experience.
6. Whether the use of basic event risk significance summed over all POSs is a suitable measure for ranking importance for establishing modeling fidelity, or, since some models change the basic event evaluation in different POSs, whether other measures must be found.	The issue was identified by a comment in an earlier LPSD Standard ballot. Alternate metrics could be defined, and all can be handled by available software. It is a suitable question for a trial use application.
7. Whether the analyst can screen out the entire category of external hazards (e.g., earthquakes) on the basis of POS duration combined with external hazards initiating event frequencies.	This issue was identified by the readiness team review of this standard. In the introduction, Section 1.1.8.2 has been added to clarify how the screening of hazards can be accomplished for each POS, where appropriate.

This standard sets forth requirements for low power and shutdown probabilistic risk assessments (PRA) and also requirements for shutdown qualitative risk assessment (QLRA) 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.

The PRA requirements in this standard are intended to be used together with other PRA standards that cover different aspects of PRA scope. Specifically, they are intended to be used directly with the PRA standard developed by the ASME and the ANS ("Standard for Level 1 / Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," ASME/ANS RA-Sa-2009 [1]).

While this LPSD Standard was being drafted for trial use ballot, a later addendum of the internal and external events at power standard, RA-Sb-2013, was published. It is the intent that this LPSD Standard will be revised to align with the available addenda or edition of the internal events at power standard prior to publication of the LPSD Standard as an ANSI standard.

This standard covers PRAs for both internal hazard events and external hazard events for a commercial nuclear power plant operating at low power or in a shutdown condition. Similarly, these PRA requirements are intended to be used with other standards now under development, including the

ASME/ANS PRA-methodology standards covering Level 2 (ASME/ANS RA-S-1.2) and Level 3 (ASME/ANS RA-S-1.3) risk assessments.

The PRA scope covered by this standard is limited to analyzing accident sequences initiated by “internal hazard events” (e.g., reactor trip, LOCAs, losses of service water, losses of offsite power, and internal flooding) or “external hazard events” (e.g., earthquakes, high winds, external flooding, etc.) that might occur while a nuclear power plant is operating at low power or is in a shutdown (i.e., non-power) condition. The exception to this scope is internal fire hazard, which is currently excluded from this standard due to the lack of methodology and applications in this area. Therefore, this standard covers all potential accident initiators arising at low power and shutdown conditions except for internal fires. The only other initiators explicitly excluded are accidents resulting from purposeful human-induced security threats (e.g., sabotage).

This standard’s PRA technical requirements are presented in support of a quantitative PRA for time-averaged core damage frequency (CDF) or LERF. For applications involving a specific LPSD evolution, modifications to the technical requirements are presented in Part 10.

The PRA requirements in this standard are further restricted to requirements for: (a) a full Level 1 analysis of the CDF; and (b) a limited Level 2 analysis sufficient to evaluate the large early release frequency (LERF).

The scope is also limited to analyzing accident sequences involving fuel while it is in the reactor vessel. Events involving fuel while it is in the spent fuel pool are not covered.

The shutdown QLRA requirements in this standard are for models used in support of configuration risk assessments while in a shutdown condition (e.g., modes 3 to 6 for PWRs and modes 3 to 5 for BWRs for mode definitions for plants with improved technical specifications).

The types of risk-informed PRA applications contemplated under this standard are very broad. Both regulatory risk-informed applications and applications independent of regulations are contemplated. While the NRC currently 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 standard, ASME/ANS RA-Sa-2009 [1]. The approach and supporting logic of ASME/ANS RA-Sa-2009 [1] are relied upon heavily in this standard’s guidance in this area.

PREPARATION OF TECHNICAL INQUIRIES TO THE JOINT COMMITTEE ON NUCLEAR RISK MANAGEMENT

INTRODUCTION

NOTE FOR TRIAL USE: The text of this section describes the technical inquiry process for approved standards. However, during the trial use period, users are encouraged to provide feedback, ask questions, and interact with the LPSD project team on either a formal or informal basis. Such feedback may be provided via the Secretary, Joint Committee on Nuclear Risk Management, as noted below, or by contacting the LPSD project team chair or another member of the project team or the JCNRM.

The ASME/ANS Joint Committee on Nuclear Risk Management (JCNRM) will consider written requests for the interpretation and revision of risk management standards and the development of new requirements as dictated by technological development. JCNRM's activities in this latter regard are strictly limited 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, The American Society of Mechanical Engineers (ASME) does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity, and, accordingly, inquiries requiring such considerations 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's requirements. If, based on the inquiry information submitted, it is the opinion of the JCNRM that the inquirer should seek assistance, the inquiry will be returned with the recommendation that such assistance be obtained.

To be considered, inquiries will require sufficient information for JCNRM to fully understand the request.

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 the standard's requirement or to propose consideration of a revision to the present requirements. Concisely provide the information needed for JCNRM'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) *Typewritten/Handwritten.* The inquiry shall be submitted in typewritten form; however, legible, handwritten inquiries will be considered;

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

(g) *Submission.* The inquiry shall be submitted to the following address: Secretary, Joint Committee on Nuclear Risk Management, The American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

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: Secretary, Joint Committee on Nuclear Risk Management, The American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

COMMITTEE ROSTERS

CONTRIBUTORS TO THE REQUIREMENTS FOR LOW POWER AND SHUTDOWN PROBABILISTIC RISK ASSESSMENT

(The following is a roster of the Joint Committee on Nuclear Risk Management at the time of the approval of this standard.)

This standard was processed and approved for release as a trial use and pilot application by the ASME/ANS Joint Committee on Nuclear Risk Management. 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 JCNRM had the following members:

ASME/ANS Joint Committee on Nuclear Risk Management (JCNRM)

R. J. Budnitz, *Cochair*, Lawrence Berkeley National Laboratory
C. R. Grantom, *Cochair*, South Texas Project Nuclear Operating Company
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ANS/ASME-58.22 (of the Standards Committee of the American Nuclear Society) was responsible for the development of this standard. It had the following membership when first formulated:

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J. A. Julius, Curtiss Wright
D. W. Stillwell, South Texas Project Nuclear Operating Company
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Additional members participating in the project team for parts of the time after inception and before completion of the final version included:

K. L. Kiper, *Chair 2003-2007,* Florida Power and Light Company

E. T. Chow, U.S. Nuclear Regulatory Commission
C. R. Grantom, South Texas Project Nuclear Operating Company
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The following project team members were participating at the time the standard was approved:

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