American Nuclear Society

design criteria for protection against the effects of compartment flooding in light water reactor plants

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ANSI/ANS-56.11-1988

American National Standard
Design Criteria for Protection Against the Effects of Compartment Flooding in Light Water Reactor Plants

Secretariat
American Nuclear Society

Prepared by the
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Working Group ANS-56.11

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American National Standard

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Foreword

(This Foreword is not a part of American National Standard Design Criteria for Protection Against the Effects of Compartment Flooding in Light Water Reactor Plants, ANSI/ANS-56.11-1988.)

This standard addresses criteria related to compartment flooding from internal sources in light water reactors. It complements and is a logical extension of several other ANSI/ANS standards already issued, or presently being prepared. These other standards, such as American National Standards Design Basis for Protection of Light Water Nuclear Power Plants Against Effects of Postulated Pipe Rupture, ANSI/ANS-58.2-1988, and Subcompartment Pressure and Temperature Transient Analysis in Light Water Reactors, ANSI/ANS-56.10-1987, address the dynamic effects of pipe ruptures (pipe whip and jet impingement) and methods to determine the mass and energy release rates from postulated piping ruptures. No detailed guidance is presently available for considering the effects of the discharge of fluid and the detection and isolation of pipe ruptures, as related to the potential for flooding structures, systems, and components.

This standard addresses three major flooding-related issues: definition of sources of internal flooding; general design requirements (which provide the overall design criteria, operability, and qualification aspects of the flood-mitigating equipment); and analysis and protective measures (which define the methodology and means to implement acceptable flooding protection). Also, information on short- and long-term recovery from the flooding event is provided, including guidance for final disposition of the flooding fluid, and conflicts with other design functions (e.g., fire protection) are discussed. This standard addresses only internal flooding effects resulting from postulated piping ruptures, and system actuations or misalignments, but not flooding due to external sources (precipitation, external flooding, and groundwater).

This standard addresses a variety of means to accommodate flooding, including both "passive" and "active." Several instances of internal flooding have occurred in the past decade, and this issue is both a safety and economic concern, as detailed in the Institute of Nuclear Power Operations (INPO) Significant Operating Experience Report, "Internal Flooding of Nuclear Power Plant Buildings," SOER 85-5, issued December 30, 1985. This issue is also of concern to the U.S. Nuclear Regulatory Commission (NRC), as evidenced from the increased recent emphasis placed on resolution of high priority Generic Issue 77, "Flooding of Safety Equipment Compartments by Backflow Through Floor Drain." These criteria and guidance reflect the current body of expertise in this area, are consistent with current industry and regulatory activities, and should help the designer to accommodate compartment flooding requirements.

Several issues within this standard are considered controversial by the working group members, and are briefly described in this foreword.

1) Use of the term "required" vs "nuclear safety-related." The term "required" is used in ANSI/ANS-58.2-1988, the "parent" document of this standard, and is equivalent to the term "essential" in the NRC's Standard Review Plan, Sections 3.6.1 and 3.6.2, dealing with pipe rupture effects. It is the working group's position that not all safety requirements are imposed on the "required" systems. The design requirements considered necessary by the working group (Seismic Category I where appropriate, single failure criteria, separation, qualification, etc.) are defined in Section 4 of the standard. Other safety requirements, such as code and safety class, QA, etc., are considered outside the scope of this standard.

2) Use of only Seismic Category I equipment to mitigate pipe rupture effects. This is consistent with ANSI/ANS-58.2-1988, but does not appear to be consistent with the

NRC's Standard Review Plan, Section 3.6.1 (specifically, paragraph B.3.b(4) of "Branch Technical Position ASB3-1"), which states that "all available systems" may be employed to mitigate the consequences of the pipe rupture. The working group has maintained the ANSI/ANS-58.2-1988 criteria with respect to postulated pipe ruptures, as well as events which could be caused by a seismic event. The working group has not required, however, that only Seismic Category I equipment be used to mitigate the consequences of flooding events caused by other sources, such as fire protection sprinkler actuation or equipment misalignments.

3) Postulation of only one break at a time in Non-Seismic Category I and non-seismically-analyzed piping systems, as the result of a seismic event. This is consistent with the working group's understanding of current industry and regulatory practice (see ANSI/ANS-58.2-1988). It also appears to be consistent with actual industry experience, such as the walkdowns taken as part of the Seismic Qualification Utility Group (SQUG) to resolve Unresolved Safety Issue A-46, "Seismic Qualification." The piping systems evaluated in industrial facilities following actual earthquake events have been shown to be very unlikely to experience significant damage.

This working group position does require, however, that the non-Seismic Category I or non-seismically analyzed piping, whether classified as high or moderate energy, be postulated to experience a circumferential or longitudinal break, as defined for high energy breaks in ANSI/ANS-58.2-1988.

4) Use of "leak-before-break." The working group references ANSI/ANS-58.2-1988 for guidance relative to postulated pipe ruptures, including size and location. The proposed revision of General Design Criteria 4 (the so-called "broad-scope GDC 4") allows the use of leak-before-break for protection against dynamic effects of pipe ruptures, but not environmental effects. The working group is aware that this obvious inconsistency is being addressed by industry and the NRC, and that the leak-before-break concept is presently being more broadly considered by the NRC for extended application to other design basis assumptions, including the environmental effects of double-ended guillotine pipe breaks. Note that the proposed revision of Branch Technical Position MEB3-1 (see preceding explanation of ASB3-1) attached to Section 3.6 of the NRC's Standard Review Plan eliminates the need to design for dynamic or environmental effects for arbitrary intermediate break locations. ANSI/ANS-58.2-1988 allows the use of leak-before-break in certain situations, with proper justification and leak detection methods. While this issue is being debated, the NRC and licensees recognize that situations may arise where proper justification (in accordance with approved leak-before-break methodologies) could serve as a basis for approving applicant/licensee requests to use more credible alternative pipe break assumptions. The NRC staff has recognized the efficiency of using this concept in combination with other considerations to address such situations.

The working group position is that, as a practical measure, "leak-before-break" methodology should not be used as a flood protection feature prior to regulatory acceptance, either generically or on a case-by-case basis. However, the future potential for its use should be recognized. If approved by the NRC, it can be used in defining the flooding source terms as outlined in subsection 3.2 of this standard, as long as any leak detection method meets the qualification requirements for "required" systems.

The membership of ANS-56.11, at the time of this standard's development, consisted of:

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