



U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

Section 7.6. Interlock Systems Important to Safety

Review Responsibilities

Primary — Instrumentation and Controls Branch (HICB)

Secondary — None

I. Areas of Review

This SRP section describes the review process and acceptance criteria for those interlock systems important to safety that operate to reduce the probability of occurrence of specific events, or to maintain safety systems in a state that ensures their availability in an accident. These systems include interlock systems to prevent overpressurization of low-pressure systems (for example, residual heat removal (RHR)) when these systems are connected to high-pressure systems (for example, primary coolant), interlocks to prevent overpressure of the primary coolant system during low-temperature operation of the reactor vessel, valve interlocks to ensure the availability of emergency core cooling system (ECCS) accumulators, interlocks to isolate safety systems from non-safety systems (for example, seismic and non-seismic portions of auxiliary supporting systems), and interlocks to preclude inadvertent inter-ties between redundant or diverse safety systems where such inter-ties exist for the purposes of testing or maintenance.

The objective of the review is to confirm that design considerations such as redundancy, independence, single failures, qualification, bypasses, status indication, and testing are consistent with the design bases of these systems and commensurate with the importance of the safety functions to be performed.

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USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

SRP Section 7.0 describes the coordination of reviews, including the information to be reviewed and the scope required for each of the different types of applications that the Office of Nuclear Reactor Regulation (NRR) may review. Refer to that section for information regarding how the areas of review are affected by the type of application under consideration and for a description of coordination between HICB and other branches.

II. Acceptance Criteria

The acceptance criteria and guidelines applicable to interlock systems are identified in SRP Section 7.1. The review of Section 7.1 of the SAR confirms that the appropriate acceptance criteria and guidelines have been identified for these systems. The review in this section of the SAR confirms that these systems conform to the requirements of the acceptance criteria and guidelines.

1. Acceptance criteria applicable to any interlock system important to safety

10 CFR 50.55a(a)(1), "Quality Standards."

10 CFR 50.55a(h), "Protection Systems," requires compliance with ANSI/IEEE Std 279, "Criteria for Protection Systems for Nuclear Power Generating Stations." For interlock systems isolated from the protection system, the only applicable requirement from ANSI/IEEE Std 279 is item 4.7.2, "Isolation Devices."

General Design Criterion 1, "Quality Standards and Records."

General Design Criterion 13, "Instrumentation and Control."

General Design Criterion 19, "Control Room."

General Design Criterion 24, "Separation of Protection and Control Systems."

2. In addition to the acceptance criteria indicated above, safety system interlocks are reviewed for conformance to the following acceptance criteria

10 CFR 50.55a(h), "Protection Systems," requires compliance with ANSI/IEEE Std 279, "Criteria for Protection Systems for Nuclear Power Generating Stations."

10 CFR 50.34(f)(2)(v), "Additional TMI-Related Requirements, Bypass and Inoperable Status Indication," or equivalent TMI action requirements imposed by Generic Letters.

General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

General Design Criterion 4, "Environmental and Missile Design Bases."

3. The following acceptance criteria are applicable to safety systems with which interlock systems may interact. These criteria are used as guidance, where applicable, in establishing the importance to safety for functions performed by interlock systems

General Design Criterion 10, "Reactor Design."

General Design Criterion 15, "Reactor Coolant System Design."

General Design Criterion 16, "Containment Design."

General Design Criterion 28, "Reactivity Limits."

General Design Criterion 33, "Reactor Coolant Makeup."

General Design Criterion 34, "Residual Heat Removal."

General Design Criterion 35, "Emergency Core Cooling."

General Design Criterion 38, "Containment Heat Removal."

General Design Criterion 41, "Containment Atmosphere Cleanup."

General Design Criterion 44, "Cooling Water."

4. Additional acceptance criteria applicable to interlock systems important to safety proposed for design certification under 10 CFR 52

10 CFR 52.47(a)(1)(iv), "Resolution of Unresolved and Generic Safety Issues."

10 CFR 52.47(a)(1)(vi), "ITAAC in Design Certification Applications."

10 CFR 52.47(a)(1)(vii), "Interface Requirements."

10 CFR 52.47(a)(2), "Level of Detail."

10 CFR 52.47(b)(2)(i), "Innovative Means of Accomplishing Safety Functions."

5. Additional acceptance criteria applicable to interlock systems important to safety proposed as part of combined license applications under 10 CFR 52

10 CFR 52.79(c), "ITAAC in Combined License Applications."

Section 7.1, Table 7-1 and Appendix 7.1-A list standards, regulatory guides, and branch technical positions that provide information, recommendations, and guidance that describe a basis acceptable to the NRC staff for implementing the relevant requirements of the NRC regulations identified above for interlock systems important to safety.

III. Review Procedures

Section 7.1 describes the general procedures to be followed in reviewing any instrumentation and control system. This part of section 7.6 highlights specific topics that should be emphasized in the interlock systems review.

The review should include an evaluation of the interlock system design against the guidance of ANSI/IEEE Std 279, or Reg. Guide 1.153, "Criteria for Power, Instrumentation, and Control Portions of Safety Systems" (which endorses IEEE Std 603, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations"), depending upon the applicant/licensee's commitment regarding these design criteria. This procedure is detailed in Appendix 7.1-B for ANSI/IEEE Std 279 and in Appendix 7.1-C for IEEE Std 603. The procedures in Appendices 7.1-B and 7.1-C address specific design requirements.

Appendices 7.1-B and 7.1-C discuss ANSI/IEEE Std 279 and IEEE Std 603, respectively, and how they are used in the review of the interlock systems. Although the primary emphasis is on the equipment comprising the interlock systems, the reviewer should consider the interlock functions on a system level. The interlock systems design should be compatible with the SAR Chapter 15 design bases accident analyses. It is not sufficient to evaluate the adequacy of the interlock systems only on the basis of the design meeting the specific requirements of ANSI/IEEE Std 279 or IEEE Std 603.

The interlock systems review should address the applicable topics identified in Table 7-1. Appendix 7.1-A describes review methods for each topic. Major design considerations that should be emphasized in the review of the interlock systems are identified below.

- Single-failure criterion — See Appendix 7.1-B item 3 or Appendix 7.1-C item 6.
- Quality of components and modules — See Appendix 7.1-B item 4 or Appendix 7.1-C item 8.
- Independence — See Appendix 7.1-B items 7 and 8 or Appendix 7.1-C item 11 and 24.
- System testing and inoperable surveillance — See Appendix 7.1-B items 10 and 11 or Appendix 7.1-C item 12, 13, and 27.
- Use of digital systems — See Appendix 7.0-A.
- Interlocks to prevent overpressurization of low pressure systems — See BTP HICB-1.
- Interlocks to prevent overpressure of the primary coolant system during low-temperature operations of the reactor vessel — See BTP RSB 5-2.
- Interlocks for ECCS accumulator valves — See BTP HICB-2.
- Interlocks required to isolate safety systems from non-safety systems and interlocks required to preclude inadvertent inter-ties between redundant or diverse safety systems.

In each safety review, the Staff should determine the elements of the design that require additional review emphasis. Typical reasons for such a non-uniform emphasis are the introduction of new design features or the

utilization in the design of features previously reviewed and found acceptable. However, in all cases, the review must be sufficient to conclude conformance to the acceptance criteria, i.e., the requirements of the Code of Federal Regulations.

IV. Evaluation Findings

The Staff verifies that sufficient information has been provided and the review supports the following conclusions as stated in the SER:

The NRC staff concludes that the design of the interlock systems is established in accordance with its safety function, is acceptable, and meets the relevant requirements of General Design Criteria (GDC) 1, 2, 4, 10, 13, 15, 16, 19, 24, 28, 33-35, 38, 41 and 44, 10 CFR 50.55a(a)(1) and 10 CFR 50.55a(h).

The Staff conducted a review of these systems for conformance to the guidelines in the regulatory guides and industry codes and standards applicable to these systems. The Staff concluded that the applicant/licensee adequately identified the guidelines applicable to these systems and has properly classified them. Based upon the review of the system design for conformance to the guidelines, the Staff finds that there is reasonable assurance that the systems fully conform to the guidelines applicable to these systems. Therefore the Staff finds that these requirements of GDC 1, 15, 16, 33-35, 38, 41, and 44, and 10 CFR 50.55a(a)(1) have been met.

Based upon the review of interlock system functions, the Staff concludes that appropriate interlocks are provided to maintain an appropriate design margin to assure that acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences. Therefore, the Staff finds that the interlock systems satisfy the requirements of GDC 10, 15, 16, 28, 33-35, 38, 41, and 44.

Based on the review of interlock system status information, initiation capabilities, and provisions to support safe shutdown, the Staff concludes that information is provided to monitor interlocks over the anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety. Appropriate controls are provided for interlock initiation and bypass. The interlocks appropriately support actions to operate the nuclear power unit safety under normal conditions and to maintain it in a safe condition under accident conditions. Therefore, the Staff finds that the interlock systems satisfy the requirements of GDC 13 and 19.

The Staff conducted a review of these systems and finds that they comply with the reliability guidance of [IEEE Std. 279 or Reg. Guide 1.153]. Based upon this review, the Staff finds that the redundancy requirements of GDC 34, 35, 38, 41, and 44 have been met.

The review included the identification of those systems and components for the interlock systems that are designed to survive the effects of earthquakes, other natural phenomena, abnormal environments, and missiles. Based upon the review, the Staff concludes that the applicant/licensee has identified those systems and components consistent with the design bases for those systems. Sections 3.10 and 3.11 of the SER address the qualification programs to demonstrate the capability of these systems and components to survive these events. Therefore, the Staff finds that the identification of these systems and components satisfies the requirements of GDC 2 and 4.

The Staff reviewed the bypassed or inoperable status indication of safety interlocks. The Staff finds that appropriate bypass indications are provided to give the operators timely information and status reports so the operators can mitigate the effects of unexpected system unavailability. The bypass

indications satisfy the guidelines of Reg. Guide 1.47. Therefore, the Staff concludes that the safety interlock systems satisfy the applicable requirements of 10 CFR 50.55a(h) and 10 CFR 50.34(f)(2)(v).

The non-safety interlock systems are appropriately isolated from safety systems. Therefore, the staff concludes that the isolation of these systems from safety systems satisfies the requirements of 10 CFR 50.55a(h) and the requirements of GDC 24.

Based on the review of interlock safety system design, the Staff concludes that the safety portions of the interlock systems comply with the requirements of [ANSI/IEEE Std 279 OR IEEE Std 603]. Therefore, the Staff finds that the interlock safety systems satisfy the requirements of 10 CFR 50.55a(h).

In the review of the interlock systems, the Staff examined the dependence of this system on the availability of essential auxiliary systems. Based on this review and coordination with those having primary review responsibility of essential auxiliary supporting (EAS) systems, the Staff concludes that the design of the interlock systems is compatible with the functional requirements of EAS systems.

Note: the following finding applies only to systems involving digital computer-based components.

Based on the review of software development plans and the inspections of the computer development process and design outputs, the Staff concludes that the computer systems meet the guidance of Reg. Guide 1.152. Therefore, the special characteristics of computer systems have been adequately addressed, and the Staff finds that the interlock systems satisfy these requirements of 10 CFR 50.55a(a)(1), GDC 1, 13, and 19.

Note: the following findings apply only to applications under 10 CFR 52.

The interlock systems design appropriately addresses the applicable unresolved and generic safety issues. Therefore, the Staff finds that the interlock systems satisfy the requirements of 10 CFR 52.47(a)(1)(iv).

The review of the interlock systems examined the proposed inspections, tests, analyses, and acceptance criteria (ITAAC). Based upon the review and coordination with those having primary responsibility for ITAAC, the Staff concludes that if the inspections, tests, and analyses are performed and the acceptance criteria are met, the plant will operate in accordance with the [design certification OR combined license]. Therefore, the Staff finds that the interlock systems satisfy the requirements of [10 CFR 52.47(a)(1)(vi) OR 10 CFR 52.79(c)].

The application for design certification does not seek certification for the following portions of the interlock systems [insert list]. Based upon review of the completed safety analysis, the Staff finds that the requirements for these portions of the design were sufficiently detailed. Therefore, the Staff finds that the interlock systems satisfy the requirements of 10 CFR 52.47(a)(1)(vii).

The interlock systems contain the following elements that differ significantly from evolutionary changes from light water reactor designs of plants that have been licensed in commercial operation before April 18, 1989. [Insert list.] Based upon the review of [analysis OR test programs OR operating experience] the Staff concludes that the performance of these features has been demonstrated; interdependent effects among the safety features are acceptable; sufficient data exist to assess the analytical tools used for safety analysis; and the scope of the design is complete

except for site-specific elements. Therefore, the Staff finds that the interlock systems satisfy the requirements of 10 CFR 52.47(b)(2)(i).

Based upon an initial review of the scope and content of the material submitted by the applicant, and completed review with respect to the technical items above, the Staff finds that the application contained appropriate detail about the interlock systems design to satisfy the requirements of 10 CFR 52.47(a)(2).

Note: the following conclusion is applicable to all applications.

The conclusions noted above for the interlock systems are applicable to all portions of the systems except for the following, for which acceptance is based upon prior NRC review and approval as noted [List applicable system or topics and identify references].

V. Implementation

Except in those cases in which the applicant/licensee proposes an acceptable alternative method for complying with specified portions of the NRC's regulations, the method described herein will be used by the NRC staff in its evaluation of conformance with NRC regulations.

VI. References

ANSI/IEEE Std 279-1971. "Criteria for Protection Systems for Nuclear Power Generating Stations."

IEEE Std 603-1991. "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations."

Regulatory Guide 1.152. "Criteria for Digital Computers in Safety Systems of Nuclear Power Plants," Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, 1996.

Regulatory Guide 1.153. "Criteria for Power, Instrumentation, and Control Portions of Safety Systems." Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, 1996.

Regulatory Guide 1.47. "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems." Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, 1973.

