



U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

4.6 FUNCTIONAL DESIGN OF CONTROL ROD DRIVE SYSTEM

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of transient and accident analyses

Secondary - Organization responsible for the review of plant design for protection of structures, systems, and components from internal and external hazards

I. AREAS OF REVIEW

The organization responsible for reactor systems reviews the functional performance of the control rod drive system (CRDS) to confirm that the system can effect a safe shutdown, respond within acceptable limits during anticipated operational occurrences, and prevent or mitigate the consequences of postulated accidents. The review covers the CRDS to ensure conformance with the requirements of General Design Criteria (GDC) 4, 23, 25, 26, 27, 28, and 29 and 10 CFR 50.62(c)(3).

The specific areas of review are as follows:

1. Examination of the CRDS design to identify possible single failures.
2. Evaluation of the CRDS to verify the following:
 - A. Essential portions can be isolated from nonessential portions.

Revision 2 - March 2007

USNRC STANDARD REVIEW PLAN

This Standard Review Plan, NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The standard review plan sections are numbered in accordance with corresponding sections in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of Regulatory Guide 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRR_SRP@nrc.gov.

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- B. The CRDS cooling system meets the design requirements.
 - C. The functional tests verify the proper rod insertion, withdrawal, and scram operation times, or that the inspections, tests, analyses, and acceptance criteria (ITAAC) are sufficient to ensure that rod insertion, withdrawal, and scram operation times will operate in accordance with the certification.
 - D. Redundant reactivity control systems are not vulnerable to common mode failures.
3. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this SRP section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.
4. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

Review Interfaces

Other SRP sections interface with this section as follows:

- 1. The review encompasses all transients and accidents in Chapter 15 of the safety analysis report (SAR) that require reactivity control systems to function. The reviewer ascertains that the reactivity and response characteristics of the reactivity control system are conservative with respect to the parameters assumed in the Chapter 15 analyses. The Chapter 15 review verifies that no credit has been taken for the recirculation flow control system (RFCS) (in boiling-water reactors (BWRs)) to mitigate any accident. (Although the RFCS controls reactor power level over a limited range, it is not required for shutdown.) In addition, the reviewer examines the operation of the RFCS to confirm that a malfunction or failure of the system will not degrade the capabilities of plant safety systems or lead to plant conditions more severe than those considered in the accident analyses (e.g., by determining the effects of a failure of the system following a loss-of-coolant accident or steam line break). The review of the results of the most limiting transient from a malfunction of the RFCS is performed under SRP Section 15.4.5.

2. Verification of the reactivity control requirements is performed under SRP Section 4.3.
3. Review of the standby liquid control system (in BWRs) is performed under SRP Section 9.3.5 and review of the safety injection system is performed under SRP Section 6.3.
4. Verification of the results of failure modes and effects analyses to ensure that a single failure occurring in the control rod system, or an operator error, will not result in the loss of capability for safe shutdown is performed under SRP Section 7.2.
5. Verification of the adequacy of the control rod drive mechanisms to perform their mechanical functions (e.g., rod insertion and withdrawal, scram operation and time) and to maintain the reactor coolant pressure boundary is performed under SRP Section 3.9.4. Verification that the design and requirements, as applicable to the assigned safety class and seismic category, are met is performed under SRP Sections 3.2.1 and 3.2.2. Under SRP Section 3.6.2, postulated piping failures inside the containment, including their associated locations and dynamic effects, are evaluated, as they relate to the protection of SSCs against such effects.
6. Determination of the acceptability of the design and analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe-shutdown earthquake, the probable maximum flood, and the tornado missiles, is performed under SRP Sections 3.3.1, 3.3.2, 3.5.3, 3.7.1 through 3.7.4, 3.8.4, and 3.8.5.
7. Verification of the adequacy of the design, installation, inspection, and testing of all electrical systems (sensing, control, and power) required for proper operation is performed under SRP Section 7.1 and Appendix 7-A and SRP Section 8.3.1.
8. The evaluation of potential sources of internal flooding and, where applicable, determination that SSCs are adequately protected against the effects of internal flooding or can otherwise function in the event of such flooding, are performed under SRP Section 3.4.1. The evaluation of potential sources of internally generated missiles and, where applicable, determination that SSCs are adequately protected against the effects of such missiles are performed under SRP Sections 3.5.1.1 and 3.5.1.2. The verification of the adequacy of specified environments and service conditions for equipment qualification as they relate to the locations of affected equipment and the overall demonstration that systems and components are qualified to perform their function are performed under SRP Section 3.11.
9. Reviews of fire protection, technical specifications, and quality assurance and maintenance are performed under SRP Sections 9.5.1 and Chapters 16 and 17, respectively.
10. Review of the seismic qualification of Category I instrumentation and electrical equipment and the environmental qualification of electrical and mechanical equipment is performed under SRP Sections 3.10 and 3.11, respectively.
11. Review of the RFCS is performed under SRP Section 7.7. Review of reactor thermal-hydraulic systems in pressurized-water reactors is performed under SRP Section 9.3.4.

12. For new BWR plant applicants, the CRDS (control rod drive pump) may be included in the systematic assessment of shutdown risks as an alternate feature that can provide core inventory makeup in the event of a loss of normal decay heat removal. The shutdown risk assessment reviews are performed under SRP Chapter 19.

The specific acceptance criteria and review procedures are contained in the referenced SRP sections.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. GDC 4 found in Appendix A to 10 CFR Part 50, as it relates to the structures, systems, and components important to safety that shall be designed to accommodate the effects of and to compatible with the environmental conditions during normal plant operation as well as during postulated accidents.
2. GDC 23, as it relates to the protection system failure modes such that the system shall fail into a safe state or into a state demonstrated to be acceptable on some other defined basis if conditions such as disconnection of system, loss of energy, or postulated adverse environment are experienced.
3. GDC 25, as it relates to the fuel design such that the specified limits are not exceeded for any single malfunction of the reactivity control system.
4. GDC 26, as it relates to the reactivity control system redundancy and capability such that two independent reactivity control systems of different design principles shall be provided and capable of reliably controlling reactivity changes under conditions of normal operation, including anticipated operational occurrences to assure acceptable fuel design limits are not exceeded. In addition, one of the systems must be capable of holding the reactor core subcritical under cold conditions.
5. GDC 27, as it relates to the combined reactivity control systems capability such that the reactivity control system design shall have a combined capability, in conjunction with poison addition by the emergency core cooling system to reliably control reactivity changes to assure that under postulated accident conditions the capability to cool the core is maintained.
6. GDC 28, as it relates to reactivity limits such that reactivity control systems shall be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity accidents can neither result in damage to the reactor coolant boundary nor disturb the core and its supports structures to impair significant capability to cool the core.

7. GDC 29, as it relates to protecting system against anticipated operational occurrences such that the design of the protection and reactor control systems should assure an extremely high probability of accomplishing their safety functions in the event of anticipated operational occurrences.
8. 10 CFR 50.62(c)(3), as it relates to those requirements that impact the CRDS functional design. Specifically for BWRs, the alternate rod injection system must be diverse and independent (from the reactor trip system) and must have redundant scram air header exhaust valves.
9. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations;
10. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for the review described in this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations.

1. To meet the requirements of GDC 4, the CRDS should remain functional and provide reactor shutdown capabilities under adverse environmental conditions and after postulated accidents.
2. To meet the requirements of GDC 23, the CRDS should fail in an acceptable condition, even under adverse conditions, that prevents damage to the fuel cladding and excessive reactivity changes during failure.
3. To meet the requirements of GDC 25, the design of the reactivity control systems should assure that a single malfunction of the CRDS will not result in exceeding acceptable fuel design limits.
4. To meet the requirements of GDC 26, the CRDS should be capable of providing sufficient operational control and reliability during reactivity changes during normal operation and anticipated operational occurrences.

5. To meet the requirements of GDC 27, the combined capability of CRDS and emergency core cooling system should reliably control the reactivity changes to assure the capability to cool the core under accident conditions.
6. To meet the requirements of GDC 28, the CRDS should be designed to assure that reactivity accidents do not result in damage to the reactor coolant pressure boundary, or result in sufficient damage to the core or support structures so as to significantly impair coolability.
7. The CRDS should be designed to ensure an extremely high probability of functioning during anticipated operational occurrences to in conformance is GDC, 29.
8. To meet the requirements of 10 CFR 50.62(c)(3), BWR plants should have an alternate rod injection system that is diverse and independent from the reactor trip system and should have redundant scram air header exhaust valves.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this SRP section is discussed in the following paragraphs:

1. GDC 4 requires that SSCs be designed to accommodate the effects of, and to be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, and be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from external events. The CRDS provides the capability to safely shut down the reactor during normal operations and anticipated operational occurrences and either prevents or mitigates the consequences associated with postulated accident scenarios. The design of the CRDS must ensure that the ability to perform these safety-related functions is not compromised by adverse environmental conditions. Compliance with GDC 4 ensures that the CRDS will remain functional under adverse postulated environmental conditions and provide essential reactor shutdown capabilities.
2. GDC 23 requires that the protection system be designed to fail into a safe state in the event of adverse conditions or environments. The CRDS provides positive core reactivity control through the use of movable control rods. The movable control rods provide reactivity control for all modes of operation, including all plant conditions from the cold shutdown condition to the full-load condition. The CRDS, in conjunction with the protection system, must actuate the control rods to effect safety-related functions when necessary to provide core protection during normal operation, anticipated operational occurrences, and accidents. Meeting the requirements of GDC 23 provides assurance that the protection system in conjunction with the CRDS will fail in a manner that prevents damage to the fuel cladding by providing positive control and preventing excessive reactivity changes during a failure.
3. GDC 25 requires that the protection system be designed to ensure that specified acceptable fuel design limits are not exceeded for any single malfunction of the reactivity control systems. The CRDS provides the motive force for the moveable control rods providing one functional method for reactivity control. Meeting the

requirements of GDC 25 by designing these systems to withstand single failures ensures that a single malfunction of the rod control drive system, such as accidental withdrawal, will not prevent proper control of core reactivity and therefore will not result in exceeding acceptable fuel design limits. Maintaining acceptable fuel design limits enhances plant safety by preventing the occurrence of mechanisms that could result in fuel cladding damage such as severe overheating, excessive cladding strain, or exceeding the thermal margin limits. Preventing excessive cladding damage ensures maintenance of the integrity of the cladding as a fission product barrier.

4. GDC 26 requires the provision of two independent reactivity control systems of different design principles. Each system must have the capability of reliably controlling reactivity changes resulting from normal operation. One of the systems shall use control rods and be capable of reliably controlling reactivity changes during anticipated operational occurrences, with appropriate margin for malfunctions such as stuck rods. In addition, one of the systems must be capable of holding the reactor core subcritical under cold conditions. The CRDS provides one of the methods for controlling reactivity changes. The CRDS is designed to control reactivity during both normal operation and anticipated operational occurrences. The CRDS should be capable of rendering a reactor subcritical under conservative conditions with the control rod with the highest rod worth fully withdrawn from the core. The conservative conditions include the highest positive reactivity contributions resulting from effects such as temperature and power and the lowest negative reactivity contributions from poisons such as xenon. Meeting the requirements of GDC 26 ensures that the CRDS will be capable of providing sufficient operational control, reliability, and safety during reactivity changes, including those during normal operation and anticipated operational occurrences.
5. GDC 27 requires that the reactivity control systems be designed to have the combined ability, in conjunction with poison addition by the emergency core cooling system, to reliably control reactivity changes under accident conditions such that the capability to cool the core is maintained. The CRDS provides the method for inserting the control rods into the reactor core when monitored plant conditions reach specified safety system setpoints. Insertion of the control rods, in conjunction with the poison addition by the emergency core cooling system, provides the means of inserting negative reactivity to rapidly shut the reactor down and ensure core coolability. Coolability, or coolable geometry, refers to the fuel assembly's ability to retain its geometry with adequate coolant channels to permit removal of residual heat. Loss of coolability can result from cladding embrittlement, violent expulsion of fuel, generalized cladding melting, structural deformation, and flow blockage because of coplanar fuel rod ballooning. Meeting the requirements of GDC 27 for the CRDS in conjunction with the emergency core cooling system enhances plant safety by ensuring that the reactor can be shut down and core coolability can be maintained.
6. GDC 28 requires that the reactivity control systems be designed with appropriate limits on the potential amount and rate of reactivity increase to prevent the adverse effects of postulated reactivity accidents. A postulated failure of the control rod system, such as rod ejection or rod dropout, has the potential to result in a relatively high rate of positive reactivity insertion which, if large enough, could cause a prompt power excursion. Such a prompt power excursion could cause a fuel element rupture, rapid fragmentation of the fuel cladding, and dispersal of fuel and cladding into the coolant. This type of event is accompanied by the conversion of nuclear energy to mechanical energy, which if

sufficient, could breach the reactor coolant pressure boundary or impair the coolability of the core. Meeting the requirements of GDC 28 for the CRDS enhances plant safety by limiting the effects of postulated reactivity accidents, thereby mitigating the adverse effects which could result in damage to the reactor coolant pressure boundary or impair the capability to cool the core.

7. GDC 29 requires that the protection and reactivity control systems be designed to ensure an extremely high probability of accomplishing their safety functions in the event of anticipated operational occurrences. The design relies on the CRDS to function in conjunction with the protection systems under anticipated operational occurrences, including loss of power to all recirculation pumps, tripping of the turbine generator, isolation of the main condenser, and loss of all offsite power. The CRDS provides an adequate means of inserting sufficient negative reactivity to shut down the reactor and prevent exceeding acceptable fuel design limits during anticipated operational occurrences. Meeting the requirements of GDC 29 for the CRDS prevents occurrence of mechanisms that could result in fuel cladding damage such as severe overheating, excessive cladding strain, or exceeding the thermal margin limits during anticipated operational occurrences. Preventing excessive cladding damage in the event of anticipated transients ensures maintenance of the integrity of the cladding as a fission product barrier.
8. 10 CFR 50.62(c)(3) requires that each BWR have an alternate rod injection system that is diverse (from the reactor trip system) from sensor output to the final actuation device. In addition, the alternate rod injection system must have redundant scram air header exhaust valves. There is a potential within all reactor trip system designs for common cause failures of identical or similar components to result in a failure to trip the CRDS. The anticipated transient without scram (ATWS) requirements address this potential and reduce the susceptibility to common mode failures in the scram systems. For BWRs, one method of providing diversity in the alternate rod injection system is the use of an “energize to trip” circuit versus a “de-energize to trip” circuit in the output devices of the scram system and the provision for redundant scram air header exhaust valves. Implementing the requirements of 10 CFR 50.62(c)(3) enhances plant safety by reducing the risk resulting from an ATWS event at BWR plants and by providing mitigation capability to permit a safe shutdown of the plant should an ATWS event occur.
9. 10 CFR 52.47(b)(1) and 10 CFR 52.80(a) require that ITAAC be identified for DCs and COLs. Because the DC or license approval is being granted before facility construction, there is a potential that the as-built configuration of a facility may not meet the requirements of the DC or COL as granted. The purpose of the ITAAC is to ensure that the as-built facility meets the requirements set forth in the DC or COL.

III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

1. The reviewer evaluates the CRDS design with respect to fluid systems and possible single failures. The review of the system description includes piping and instrumentation diagrams (P&IDs), layout drawings, process flow diagrams, and descriptive information on essential supporting systems. The review evaluates the SAR to ascertain that failure modes and effects analyses have been completed to determine that the CRDS (not the individual drives) is capable of performing its safety-related function following the loss of any active component.
2. The reviewer evaluates the CRDS, P&IDs, layout drawings, and component descriptions and characteristics to verify that essential portions of the system are correctly identified and are isolable from nonessential portions. The essential portions should be protected from the effects of dynamic conditions (such as high- or moderate-energy line breaks). The reviewer examines layout drawings of the system to ensure that no high- or moderate-energy piping systems are close to the CRDS, or that protection is provided from the effects of high- or moderate-energy pipe breaks. If the dynamic effects of pipe ruptures are proposed to be excluded from the design basis, then the review includes analyses justifying the exclusion. When an essential system or component is designed to perform multiple functions, the review encompasses the additional operating modes to ensure that there can be no adverse impacts on the essential system function. The reviewer should ensure that systems not relied on for safe shutdown cannot impair essential or passive component functions. Where two or more reactivity systems are used, the reviewer evaluates the combined functional performance under accident conditions.
3. For plants containing control rod drive cooling systems (e.g., using air or water as coolant), the reviewer examines descriptions and drawings to determine that the systems meet the design requirements. The SAR should delineate essential equipment. The reviewer of transient and accident analyses confirms by failure modes and effects analysis that the cooling system is capable of maintaining the CRDS temperature below the applicant's maximum temperature criterion. The review performed under SRP Section 7.2 confirms that there are sufficient instrumentation and controls available so that the reactor operator in the control room can monitor the CRDS conditions, including the more significant parameters such as coolant flow, temperature, pressure, and stator temperature.
4. Reviewers examine the functional tests of the CRDS related to rod insertion and withdrawal and scram operation and time. The reviewers check the elements of the test program to ensure that all required thermal-hydraulic conditions have been included for all postulated operating conditions. The test program should include experimental verification of system operation where a single failure has been assumed (e.g., accumulator leakage for hydraulic CRDS and stuck rod operation). The reviewers ensure that the system requirements (such as required scram times) are clearly identified and are consistent with the system requirements in the technical specifications and SRP Sections 14 and 15.
5. The reactivity control systems are evaluated to verify that redundant reactivity control systems are not vulnerable to common mode failures. The review identifies the common mode failures and evaluates transient and accident analyses under SRP Sections 7.4, 3.9.4, and 9.3.4 or 9.3.5.

6. For BWR plants that have a scram discharge volume (SDV), the reviewer evaluates the system capabilities and controls to verify that the design of the SDV and its associated systems satisfies the guidance and criteria contained in the NRC BWR scram discharge safety evaluation report (SER). For BWR plants without an SDV, the guidance and criteria specific to the SDV portions of the system would not apply; however, one of the issues addressed within the SER is the response of the CRDS to a slow loss of control air pressure in the scram system. For BWR plants without an SDV, the reviewer should verify that the design incorporates features to prevent the loss or impairment of the scram function resulting from a slow loss of control air pressure in the system.
7. For BWRs, the reviewer evaluates the alternate rod injection systems in regard to the rod control drive systems to verify that the systems have the capability for automatic insertion of all rods by an independent and diverse (from the reactor protection system) method as necessary for mitigation of an ATWS. The evaluation of the alternate rod injection systems includes verification of the use of redundant scram air header exhaust valves.
8. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).
9. For review of both DC and COL applications, SRP Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section.

Upon request from the primary reviewer, the organization with secondary responsibilities will provide input for the areas of review stated in Subsection I. The primary reviewer obtains and uses such input as required to ensure that this review procedure is complete.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The staff has reviewed the functional design of the control rod drive system (CRDS) to confirm that the system has the capability to shut down the reactor with appropriate margin during normal operation, anticipated operational occurrences, and accident conditions, including single failures. For pressurized-water reactors, the chemical and volume control system augments the CRDS to maintain safe shutdown. The scope of review included process flow diagrams, layout drawings, piping and instrumentation diagrams, and descriptive information for the systems and for the supporting systems essential for operation of the system.

The review has determined the adequacy of the applicant's proposed design criteria, design basis, and safety classification of the CRDS and the requirements for providing a safe shutdown during normal operation, anticipated operational occurrences, and accident conditions, including single failures. The staff concludes that the design of the CRDS is acceptable and meets the requirements of General Design Criteria (GDC) 4, 23, 25, 26, 27, 28, and 29 and 10 CFR 50.62(c)(3). This conclusion is based on the following:

1. The applicant has met the requirements of GDC 4 with respect to the design of the system against the adverse effects of missile hazards inside the containment, pipe whipping and jets caused by broken pipes, and adverse environmental conditions resulting from high- and moderate-energy pipe breaks during normal plant operations, anticipated operational occurrences, and accident conditions.
2. The applicant has met the requirements of GDC 23 by demonstrating the ability to insert the control rods upon any failure of the drive mechanism or any induced failure by an outside force (e.g., loss of electric power, instrumentation air, fire, radiation, extreme heat, pressure, cold, water, steam).
3. The applicant has met the requirements of GDC 25 by ensuring that no fuel design limits are exceeded for any single malfunction or rod withdrawal accident.
4. The applicant has met the requirement of GDC 26 by demonstrating the ability to control reactivity changes to ensure that, under normal operation and anticipated operational occurrences with the appropriate margin for malfunction (such as stuck rods), no fuel design limits are exceeded and the reactor can be maintained subcritical under cold conditions.
5. The applicant has met the requirements of GDC 27 by demonstrating the ability to reliably control reactivity changes under accident conditions to ensure that no fuel design limits are exceeded and the reactor can be maintained subcritical under cold conditions.
6. The applicant has met the requirements of GDC 28 by demonstrating the ability to reliably control the amount and rate of reactivity change to ensure that no reactivity accident will damage the reactor coolant pressure boundary or disturb the core or the core's appurtenances such as to impair coolant flow. The postulated reactivity accidents include rod ejection, rod drop, steamline rupture, coolant temperature changes, pressure changes, and cold water addition.
7. The applicant has met the requirements of GDC 29 by demonstrating a high probability of control rod insertion under anticipated operational occurrences.
8. The applicant has met the requirements of 10 CFR 50.62(c)(3) by demonstrating that the alternate rod injection system is diverse and independent from the reactor trip system and by providing redundant scram air header exhaust valves.

For DC and COL reviews, the findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this SRP section.

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable.

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications submitted six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 23, "Protection System Failure Modes."
2. 10 CFR Part 50, Appendix A, General Design Criterion 25, "Protection System Requirements for Reactivity Control Malfunctions."
3. 10 CFR Part 50, Appendix A, General Design Criterion 26, "Reactivity Control System Redundancy and Capability."
4. 10 CFR Part 50, Appendix A, General Design Criterion 27, "Combined Reactivity Control Systems Capability."
5. 10 CFR Part 50, Appendix A, General Design Criterion 28, "Reactivity Limits."
6. 10 CFR Part 50, Appendix A, General Design Criterion 29, "Protection Against Anticipated Operational Occurrences."
7. 10 CFR 50.62, "Requirements for Reduction of Risk from Anticipated Transients Without Scram (ATWS) Event for Light-Water-Cooled Nuclear Power Plants."
8. NUREG-0460, Vols. 1-4, "Anticipated Transients Without Scram for Light Water Reactors," Office of Nuclear Reactor Regulation.
9. NUREG-1000, Vols. 1-2, "Generic Implications of ATWS Events at the Salem Nuclear Power Plant," Office of Nuclear Reactor Regulation.
10. Generic Letter 80-107, "BWR Scram Discharge System," December 9, 1980.
11. Generic Letter 81-18, "BWR Scram Discharge System; Clarification of Diverse Instrumentation Requirement," March 31, 1981.

12. Memorandum for G.C. Lainas, from P.S. Check, "BWR Scram Discharge System Safety Evaluation," December 1, 1980.

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.
