U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

3.9.4 CONTROL ROD DRIVE SYSTEMS

REVIEW RESPONSIBILITIES

Primary - Mechanical Engineering Branch (EMEB)[1]

Secondary - None

I. AREAS OF REVIEW

The control rod drive system (CRDS) consists of the control rods and the related mechanical components which provide the means for mechanical movement. General Design Criteria 26 and 27 require that the CRDS provide one of the independent reactivity control systems. The rods and the drive mechanism shall be capable of reliably controlling reactivity changes either under conditions of normal operation, including ~~conditions of~~ anticipated ~~normal plant~~[2] operational occurrences, or under postulated accident conditions. A positive means for inserting the rods shall always be maintained to ensure appropriate margin for malfunction, such as stuck rods. Since the CRDS is a system important to safety and portions of the CRDS are a part of the reactor coolant pressure boundary (RCPB), General Design Criteria 1, 2, 14, and 29 and 10 CFR Part 50, §50.55a, require that the system shall be designed, fabricated, and tested to quality standards commensurate with the safety functions to be performed, so as to assure an extremely high probability of accomplishing the safety functions either in the event of anticipated operational occurrences or in withstanding the effects of postulated accidents and natural phenomena such as earthquakes.

Information in the areas noted below is provided in the applicant's safety analysis report and is reviewed by the EMEB[3] in accordance with this SRP section. This information pertains to the CRDS, which is considered to extend to the coupling interface with the reactivity control

elements in the reactor pressure vessel. For electromagnetic systems, the review under this SRP section is limited to just the control rod drive mechanism (CRDM) portion of the CRDS. For hydraulic systems, the review covers the CRDM and also the hydraulic control unit, the condensate supply system, and the scram discharge volume. For both types of systems, the CRDM housing should be treated as part of the RCPB; the relevant mechanical engineering information may be presented in this SRP section or by reference to the sections on the RCPB.

If other types of CRDS are proposed or if new features that are not specifically mentioned here are incorporated in CRDS of current types, information should be supplied for the new systems or new features similar to that described below.

1. The descriptive information, including design criteria, testing programs, drawings, and a summary of the method of operation of the control rod drives, is reviewed to permit an evaluation of the adequacy of the system to perform its mechanical function properly.

2. A review is performed of information pertaining to design codes, standards, specifications, and standard practices, as well as to General Design Criteria, regulatory guides, and branch positions that are applied in the design, fabrication, construction, and operation of the CRDS.

   The various criteria, described in general terms above, should be supplied along with the names of the apparatus to which they apply. Pressurized portions of the system which are a part of RCPB are reviewed to determine the extent to which the applicant complies with the Class 1 requirements of Section III of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Reference 14, hereafter "the Code")[4]. Those portions which are not part of the RCPB are reviewed with other specified parts of Section III, or other sections of the Code. The EMEB[5] reviews the non-pressurized portions of the control rod drive system to determine the acceptability of design margins for allowable values of stress, deformation, and fatigue used in the analyses. If an experimental testing program is used in lieu of analysis, the program is reviewed to determine whether it adequately covers the areas of concern in stress, deformation, and fatigue.

3. Information is reviewed which pertains to the applicable design loads and their appropriate combinations, to the corresponding design stress limits, and to the corresponding allowable deformations. The deformations are of interest in the present context only in those instances where a failure of movement could be postulated due to excessive deformation and such movement would be necessary for a safety-related function.

   If the applicant selects an experimental testing option in lieu of establishing a set of stress and deformation allowables, a detailed description of the testing program must be provided for review. In the preliminary safety analysis report (PSAR), the load combinations, design stress limits and allowable deformations criteria should be provided for review.

In the final safety analysis report (FSAR) for operating license or standard safety analysis report (SSAR) for design certification (DC) applications[6], the actual design should be compared with the design criteria and limits to demonstrate that the criteria and limits have not been exceeded.

Loadings imposed during normal plant operation and startup and shutdown transients include but are not limited to pressure, deadweight, temperature effects, and anticipated operational occurrences. Loadings associated with specific seismic and other dynamic events are then combined with the above plant-type loads. For BWRs only, the CRDS is reviewed to verify that the system is capable of withstanding adverse dynamic loads such as water hammer. The response to each set of combined loads has a selected stress or deformation limit. The selection of a specific limit is influenced by the probability of the postulated event occurring and the need to assure operation during and after the event.

4. The portion of the SAR is reviewed that describes plans for the conduct of an operability assurance program or that references previous test programs or standard industry procedures for similar apparatus. For example, the life cycle test program for the CRDS is reviewed. The operability assurance program is reviewed to ascertain coverage of the following:

   a. Life cycle test program.

   b. Proper service environment imposed during test, including appropriate conditions for normal operation,[7] anticipated ~~normal~~ operational occurrences, seismic, and postulated accident conditions.

   c. Mechanism functional tests.

   d. Program results.

Review Interfaces:[8]

The EMEB also performs the following reviews under the SRP sections indicated:[9]

1. Verifies that CRDS pressure-retaining components are acceptably classified and that corresponding appropriate quality standards are applied, as part of its primary review responsibility for SRP Sections 3.2.2 and/or 5.2.1.1.[10]

2. Evaluates BWR CRDS piping with respect to locations and effects of postulated piping failures under SRP Section 3.6.2.[11]

In addition, the EMEB[12] will coordinate other branches' evaluations that interface with the overall review of the CRDS as follows:

1.[13] The ~~Core Performance Branch (CPB)~~Reactor Systems Branch (SRXB)[14] ~~will verify~~evaluates the adequacy of the[15] fuel system design, including effects of the CRDS on fuel behavior in meeting the requirements of the reactor core design under various

normal operating[16] and accident ~~operating~~ conditions in SRP Section 4.2. The SRXB also reviews the functional design of reactivity control systems, including the CRDS and its design for protection against the effects of postulated piping and equipment failures, in SRP Section 4.6.[17]

2.[18] The ~~Materials Engineering Branch (MTEB)~~Materials and Chemical Engineering Branch (EMCB)[19] reviews the adequacy of programs for assuring the integrity of bolting and threaded fasteners as part of its primary review responsibility for SRP Section 3.13 (proposed). The EMCB also ~~will~~ reviews[20] the material aspects of CRDS in SRP Section 4.5.1.

3.[21] The Plant Systems Branch (SPLB) verifies the adequacy of specified environments and service conditions for equipment qualification and of the overall demonstration that components of the CRDS are qualified to perform their functions, as part of its primary review responsibility for SRP Section 3.11.[22]

For those areas of review identified above as part of the ~~primary~~ review ~~responsibility of other branches~~under other SRP sections, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP sections ~~of the corresponding primary branch~~[23].

II. ACCEPTANCE CRITERIA

EMEB[24] acceptance criteria are based on meeting the requirements of the following regulations:

~~1~~A[25]. GDC 1 and 10 CFR Part 50, §50.55a, as its relates to CRDS, requires that the CRDS be designed to quality standards[26] commensurate with the importance of the safety functions to be performed.

~~2~~B. GDC 2, as it relates to CRDS, requires that the CRDS be designed to withstand the effects of an earthquake without loss of capability to perform its safety functions.

~~3~~C. GDC 14, as it relates to CRDS, requires that the RCPB portion of the CRDS be designed, constructed, and tested for the extremely low probability of leakage or gross rupture.

~~4~~D. GDC 26, as it relates to CRDS, requires that the CRDS be one of the independent reactivity control systems which is designed with appropriate margin to assure its reactivity control function under ~~anticipated~~conditions of normal operati~~n~~on, ~~condition~~ including anticipated operational occurrences[27].

~~5~~E. GDC 27, as it relates to CRDS, requires that the CRDS be designed with appropriate margin, and in conjunction with the emergency core cooling system, be capable of controlling reactivity and cooling the core under postulated accident conditions.

~~6~~F. GDC 29, as its relates to CRDS, requires that the CRDS, in conjunction with reactor protection systems, be designed to assure an extremely high probability of accomplishing its safety functions in the event of anticipated operational occurrences.

Specific criteria necessary to meet the relevant requirements of the regulations identified above are as follows:

1. The descriptive information is determined to be sufficient provided the minimum requirements for such information meet Section 3.9.4 of Reference ~~11~~10[28].

2. Construction (as defined in NCA-111O of Section III of the ASME Code~~, Reference 7~~[29]) should meet the following codes and standards utilized by the nuclear industry which have been reviewed and found acceptable:

   a. Pressurized Portions of Equipment Classified as Quality Group A, B, C (Regulatory Guide 1.26)

      Section III of the ASME Code, Class 1, 2, or 3 as appropriate ~~(Ref. 7)~~[30].

   b. Pressurized Portions of Equipment Classified as Quality Group D (Regulatory Guide 1.26)

      (1) Section VIII, Division 1 of the ASME Code for vessels and pump casings ~~(Ref. 7)~~[31].

      (2) Applicable to Piping Systems (American National Standards Institute, ANSI):(1)

      B16.5 Steel Pipe Flanges and Flanged Fittings (Ref~~.~~erence ~~13~~15[32]).
      B16.9 Steel Butt Welding Fittings (Ref~~.~~erence ~~14~~16[33]).
      B16.11 Steel Socket Welding Fittings (Ref~~.~~erence ~~15~~17[34]).
      B16.25 Butt Welding Ends (Ref~~.~~erence ~~16~~18[35]).
      B16.34 Steel Valves with Flanged and Butt Welding Ends[36] (Ref~~.~~erence ~~19~~19[37]).
      B31.1 Power [38]Piping (Ref~~.~~erence ~~17~~20[39]).
      MSS-SP-25[40] ~~Standards~~Marking for Valves, Fittings, Flanges, and Unions[41] (Ref~~.~~erence ~~18~~21[42]).

   c. Nonpressurized Equipment (Non-ASME Code)

      Design margins presented for allowable stress, deformation, and fatigue should be equal to or greater than those for other plants of similar design having a period of successful operation. Justification of any decreases should be provided.

3. For the various design and service conditions defined in NB-3113 of Section III of the ASME Code ~~(Ref. 7)~~[43], load combination sets are as given in Standard Review Plan Section 3.9.3 ~~(Ref. 12)~~.[44]

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(1)This list can be extended by a staff review and acceptance of other ANSI and MSS standards in the piping system area.

The stress limits applicable to pressurized and nonpressurized portions of the control rod drive systems should be as given in ~~Reference 12~~SRP Section 3.9.3[45] for the response to each loading set. For BWRs, t~~T~~he[46] CRDS design should adequately consider water hammer loads to assure that system safety functions can be achieved.

4. The operability assurance program will be acceptable provided the observed performance as to wear, functioning times, latching, and overcoming a stuck rod meet system design requirements.

Technical Rationale:[47]

The technical rationale for application of the above acceptance criteria to the CRDS is discussed in the following paragraphs:

1. GDC 1 and 10 CFR 50.55a establish requirements regarding the quality standards to be applied to the CRDS. Specifically, 10 CFR 50.55a identifies the ASME Code requirements, Code editions, and addenda which must be applied to pressure-retaining portions of the CRDS that are of the highest importance to safety and Regulatory Guide 1.26 identifies acceptable standards to be applied for pressure-retaining portions of the CRDS that are less important to safety but which may contain radioactive material. The CRDS is an independent reactivity control system designed to ensure the capability to control reactivity changes in the reactor under both normal operating and accident conditions. The fuel cladding and reactor coolant pressure boundary (RCPB) are protected by CRDS safety functions which include insertion of adequate negative reactivity to preserve these fission product barriers under specified conditions. In addition, the CRDS comprises a portion of the RCPB thus providing a barrier to the release of fission products. The application of GDC 1 and 10 CFR 50.55a requirements to the design, fabrication, erection and testing ensures the CRDS meets quality standards that are adequate to provide assurance that these safety functions will be performed.

2. GDC 2 establishes requirements regarding the ability of the CRDS to withstand the effects of an earthquake. The CRDS must satisfy seismic Category I requirements and be capable of controlling reactivity when subject to a seismic disturbance thereby ensuring that the fission process can be rapidly terminated under the same conditions. Consequently, plant protection and safety is augmented by the capability of the CRDS to perform its safety function under earthquake conditions.

3. GDC 14 establishes requirements regarding the RCPB portion of the CRDS. The CRDM is relied upon, in part, to provide a barrier to the release of fission products to the containment through proper design of the control rod drive housing and components that are part of the RCPB. Application of the GDC 14 criteria to the CRDM components functioning as a RCPB increases safety by ensuring that the RCPB will have an extremely low probability of failure.

4. GDC 26 establishes requirements regarding the reactivity control systems redundancy and capability. The CRDS is one of the reactivity control systems relied upon during normal operating and anticipated operational occurrences to control reactivity changes to

ensure that the fuel design limits are not exceeded. Application of GDC 26 criteria to the CRDS improves safety by providing protection for the fuel matrix and cladding, the primary barrier to the release of fission products.

5. GDC 27 establishes requirements regarding the combined reactivity control system capability. The CRDS is one of the reactivity control systems relied upon during postulated accident conditions to control reactivity changes to ensure that the capability to cool the core is maintained. Requiring compliance with GDC 27 for the CRDS augments the protection provided for the primary fission product barrier by providing one means to ensure that the core, under postulated accident conditions, will be maintained in a coolable geometry.

6. GDC 29 establishes requirements regarding the capability of the CRDS to accomplish its safety functions in the event of anticipated operational occurrences. In order to provide protection for the fuel matrix and cladding, the primary barrier to the release of fission products, the CRDS must have a high probability of accomplishing its safety function during anticipated operational occurrences. Application of this requirement augments plant protection and safety by requiring a highly reliable fast-acting control rod drive mechanism capable of operation during anticipated operational occurrences.

7. The specified codes and standards establish requirements for construction of the applicable portions of the CRDS. The individual components of the CRDS must be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed by that component. The individual codes and standards each provide a set of applicable limits that the design must meet in order to ensure that the applicable component can carry out its designated safety function.

III. REVIEW PROCEDURES

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

1. The objectives of the review are to determine that design, fabrication, and construction of the control rod drive mechanisms provide structural adequacy and that suitable life cycle testing programs have been utilized to prove operability under service conditions.

   In the construction permit (CP) review, it should be determined that the design criteria utilize proper load combinations, stress and deformation limits, and that operability assurance is provided by reference to a previously accepted testing program or that a commitment is made to perform a testing program which includes the essential elements listed below. In the operating license (OL) review, the results of any testing program not previously reviewed should be evaluated.

2. The design criteria presented should be evaluated for both the internal pressure-containing portions and other portions of the CRDS. These include the CRDM

housing, hydraulic control unit, condensate supply system and scram discharge volume, and portions such as the cylinder, tube, piston, and collect assembly.

Of particular concern are any new and unique features which have not been used in the past. Pressure-containing components are checked to ensure that they meet the design requirements of the codes and criteria which have been accepted by the Mechanical Engineering Branch, and are identified in Standard Review Plan Section 3.2.2. The review of the functional design of reactivity control systems, including control rod drive systems, is the responsibility of the Reactor Systems Branch (~~RSB~~SRXB)[48] (see SRP Section 4.6). The loading combinations for the various plant operating conditions are checked for consistency with ~~Reference 12~~SRP Section 3.9.3[49]; given these loading combinations, the stress limits of the appropriate code should not be exceeded, or the limits in ~~Reference 12~~SRP Section 3.9.3[50] should not be exceeded if not specified in the listed design code.

For BWR control rod drive systems which include a scram discharge volume system, the reviewer verifies that the system piping design meets or exceeds the acceptable owner's group classifications and criteria discussed in the enclosure to Reference 13 to ensure that breaks and through wall cracks in the piping need not be postulated. The reviewer also verifies that acceptable commitments are made regarding associated inspections, periodic visual verification of the scram system piping integrity, and emergency actions in response to detected leakage to adequately address prevention and mitigation of the effects of leakage associated with potential failures of this piping.[51]

For BWR control rod drive systems that include a control rod drive return line, the reviewer verifies acceptable commitments for the return line design and its implementation in accordance with Reference 12 and Part II, Section 8 of Reference 11.[52]

~~Exceptions taken by the applicant to any of the accepted codes, standards, or NRC criteria must be identified and the basis clearly justified so that evaluation is possible. Engineering judgment, experience, comparisons with earlier cases and design margins, and consultation with supervisors permit the reviewer to reach a decision on the acceptability of any exceptions posed by the applicant.~~[53]

The choice of structural materials of construction for the CRDS is reviewed by the ~~MTEB~~EMCB[54] in SRP Section 4.5.1.

3. Loading combinations are defined as those loadings associated with plant operations which are expected to occur one or more times during the lifetime of the plant and include but are not limited to loss of power to all recirculation pumps, tripping of the turbine generator set, isolation of the main condenser, and loss of all offsite power, combined with loadings caused by natural or accident events including, for BWRs, water hammer loads. The load combinations which are postulated to occur are specified for each of the design and service conditions as defined in Paragraph NB-3113 of the ASME Code ~~(Ref. 7)~~[55]. These load combinations are defined in ~~Reference 12~~SRP Section 3.9.3[56] and are compared by the reviewer with those provided by the applicant.

The design stress limits, including fatigue limits, and deformation limits as appropriate to the components of the control rod drive mechanism are compared by the reviewer with those of specified codes, previously designed and successfully operating systems, or with the results of scale model and prototype testing programs.

4. The control rod drive mechanisms of a new design or configuration should be subjected to a life cycle test program to determine the ability of the drives to function during and after normal operation~~ing~~[57], pressure testing,[58] anticipated operational occurrences[59], seismic, and postulated accident conditions[60] over the full range of temperatures, pressures, loadings, and misalignment expected in service. The tests should include functional tests to determine times of rod insertion and withdrawal, latching operation, scram operation and time, system valve operation and scram accumulator leakage for hydraulic CRDS, ability to overcome a stuck rod condition, and wear. Rod travel and number of operational[61] trips and test trips[62] expected during the mechanism operational life should be duplicated in the tests.

   The reviewer checks the elements of the test program to be sure all required parameters have been included and finally reviews the test results to determine acceptability. Excessive wear, malfunction of components, operating times beyond determined limits, scram accumulator leakage, etc., all would be cause for retesting.

Exceptions taken by the applicant to any of the accepted codes, standards, or NRC criteria must be identified and the basis clearly justified so that evaluation is possible. Engineering judgment, experience, comparisons with earlier cases and design margins, and consultation with supervisors permit the reviewer to reach a decision on the acceptability of any exceptions posed by the applicant.[63]

For standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.[64]

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided to satisfy the requirements of this SRP section and that ~~his~~the[65] evaluation is sufficiently complete and adequate to support conclusions of the following type, to be included in the staff's safety evaluation report:

   The staff concludes that the design of the control rod drive system is acceptable and meets the requirements of General Design Criteria 1, 2, 14, 26, 27, and 29, and 10 CFR Part 50, §50.55a. This conclusion is based on the following:

1. The applicant has met the requirement of GDC 1 and 10 CFR Part 50, §50.55a, with respect to designing components important to safety to quality standards commensurate

with the importance of the safety functions to be performed. The design procedures and criteria used for the control rod drive system are in conformance with the requirements of appropriate ANSI and ASME Codes.

2. The applicant has met the requirements of GDC 2, 14, and 26 with respect to designing the control rod drive system to withstand effects of earthquakes and conditions of normal operation, including anticipated ~~normal~~ operational[66] occurrences with adequate margins to assure its reactivity control function and with extremely low probability of leakage or gross rupture of reactor coolant pressure boundary. ~~The CRDS design capabilities include the ability to accommodate water hammer dynamic loads resulting from rapid opening of the scram insert and withdraw valves and closure of the hydraulic buffer under the worst case loading condition without compromising the safety functions of the system.~~[67] The specified design transients, design and service loadings, combination of loads, and limiting the stresses and deformations under such loading combinations are in conformance with the requirements of appropriate ANSI and ASME Codes and acceptable regulatory positions specified in SRP Section 3.9.3. For BWRs, also include the following:[68] The CRDS design capabilities include the ability to accommodate water hammer dynamic loads resulting from rapid opening of the scram insert and withdraw valves and closure of the hydraulic buffer under the worst case loading condition without compromising the safety functions of the system.[69]

3. The applicant has met the requirements of GDC 27 and 29 with respect to designing the control rod drive system to assure its capability of controlling reactivity and cooling the reactor core with appropriate margin, in conjunction with either the emergency core cooling system or the reactor protection system. The operability assurance program is acceptable with respect to meeting system design requirements in observed performance as to wear, functioning times, latching, and overcoming a stuck rod.

For design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluation of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.[70]

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.[71] Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.[72]

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides and in References 1, 11, and 12. ~~and i~~ Implementation[73] of the[74] acceptance criterion associated The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.[75].

(b) ~~CP applicants~~Applications docketed during or after April 1984[76] will be required to comply with the provisions of this item~~revision~~[77].

VI. REFERENCES[78]

1. 10 CFR Part 50, §50.55a, "Codes and Standards."[79]

~~1~~2. 10 CFR Part 50, Appendix A, General Design Criterion 1, "Quality Standards and Records."

~~2~~3. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

~~3~~4. 10 CFR Part 50, Appendix A, General Design Criterion 14, "Reactor Coolant Pressure Boundary."

~~4~~5. 10 CFR Part 50, Appendix A, General Design Criterion 26, "Reactivity Control System Redundancy and Capability."

~~5~~6. 10 CFR Part 50, Appendix A, General Design Criterion 27, "Combined Reactivity Control Systems Capability."

~~6~~7. 10 CFR Part 50, Appendix A, General Design Criterion 29, "Protection Against Anticipated Operational Occurrences."

8. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."[80]

9. Regulatory Guide 1.29, "Seismic Design Classification."

~~10. Regulatory Guide 1.48, "Design Limits and Loading Combinations for Seismic Category I Fluid System Components."[81]~~

~~11~~10. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."

~~12. Standard Review Plan Section 3.9.3, "ASME Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures."[82]~~

11. NUREG-0619, "BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking," November 1980.[83]

12. NRC Letter to BWR Applicants and Licensees, "Final Edition of NUREG-0619, "BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking" (Generic Letter No. 80-95)," November 13, 1980.[84]

13. NRC Letter to all BWR Applicants and Licensees, "Safety Concerns Associated with Pipe Breaks in the BWR Scram System (Generic Letter No. 86-01)," January 3, 1986.[85]

~~7~~14. ASME Boiler and Pressure Vessel Code, Section~~s~~ III, "Nuclear Power Plant Components," and Section VIII, Division 1, "Pressure Vessels,"[86] American Society of Mechanical Engineers.

~~13~~15. ANSI B 16.5, "Steel Pipe Flanges and Flanged Fittings," American National Standard Institute.[87]

~~14~~16. ANSI B 16.9, "Wrought Steel Butt Welding Fittings," American National Standard Institute.[88]

~~15~~17. ANSI B 16.11, "Steel Fittings Steel Welding and Threaded," American National Standard Institute.[89]

~~16~~18. ANSI B 16.25, "Butt Welding Ends - Pipe, Valves, Flanges, and Fittings," American National Standard Institute.[90]

~~19~~19. ANSI B 16.34, "Steel Valves with Flanged and Butt Welding Ends," American Society of Mechanical Engineers.[91]

~~17~~20. ANSI B 31.1, "Power Piping," American National Standard Institute.[92]

~~18~~21. MSS-SP-25, "Marking for Valves, Fittings, Flanges, and Unions," Manufacturers Standardization Society.[93]

SRP Draft Section 3.9.4
Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	Current PRB names and abbreviations	Editorial change made to reflect current PRB names and responsibilities for SRP sections.
2.	Generic Issue B3 "Event Categorization"	Revised event categorizations and descriptions to be consistent with the CFRs and the GDCs which separate the terms anticipated operational occurrences and normal operation. This is consistent with the design of the CRDS which per GDCs 26, 27, and 29 shall be capable of controlling reactivity changes under conditions of normal operation, including anticipated operational occurrences and under postulated accident conditions.
3.	Current PRB names and abbreviations	Editorial change made to reflect current PRB names and responsibilities for SRP sections.
4.	SRP-UDP format item	Added identification by reference number for the first citation of the ASME Code in the SRP section.
5.	Current PRB names and abbreviations	Editorial change made to reflect current PRB names and responsibilities for SRP sections.
6.	10 CFR 52 applicability-related changes	Added a statement to include design certification (DC) phase reviews of design criteria and limits to demonstrate that the criteria and limits are not exceeded. Reviews of the CRDM design criteria for evolutionary or advanced plants are conducted at the design certification phase.
7.	Generic Issue B3 "Event Categorization"	Revised event categorizations and descriptions to be consistent with the CFRs and the GDCs which separate the terms anticipated operational occurrences and normal operation. This is consistent with the design of the CRDS which per GDCs 26, 27, and 29 shall be capable of controlling reactivity changes under conditions of normal operation, including anticipated operational occurrences and under postulated accident conditions.
8.	SRP-UDP format item	Added underlined title for Review Interface section.
9.	SRP-UDP format item, Editorial	Editorial change to add the typical lead-in sentence for those SRP sections that are review interfaces with SRP Section 3.9.4, and are also the responsibility of the PRB for SRP Section 3.9.4.
10.	Editorial	Added review interface reflecting the review under SRP Section 3.2.2 which is referenced in review procedure III.2.

Item	Source	Description
11.	**Integrated Impact 935**	Added a review interface reflecting review of BWR CRDS piping located inside containment with respect to locations and effects of postulated CRDS piping failures.
12.	Current PRB names and abbreviations	Editorial change made to reflect current PRB names and responsibilities for SRP sections.
13.	SRP-UDP format item	Revised review interface section of Areas of Review to be consistent with SRP-UDP required format which uses a number/paragraph format to distinguish individual reviews performed by other PRBs.
14.	Current PRB names and abbreviations	Editorial change made to reflect current PRB names and responsibilities for SRP Section 4.2.
15.	Editorial	Revised to clarify the description of the review performed in SRP Section 4.2. The statement "will verify fuel system design" was less than optimally descriptive.
16.	Generic Issue B3 "Event Categorization"	Moved the word "operating" so as to be logically connected with "normal" but not with "accident." Common terminology refers to normal operating conditions separately and apart from accident conditions.
17.	Potential Impact 25424, Editorial	Added review interface with SRP Section 4.6 to address the functional design review of the reactivity control systems consistent with current review procedure 2. Also added description of an SRP Section 4.6 review related to determining compliance with GDC 4.
18.	SRP-UDP format item	Revised review interface section of Areas of Review to be consistent with SRP-UDP required format which uses a number/paragraph format to distinguish individual reviews performed by other PRBs.
19.	Current PRB names and abbreviations	Editorial change made to reflect current PRB names and responsibilities for SRP Section 4.5.1.
20.	SRP-UDP Integration of Bolting Issues, Potential Impact 995	Added a review interface reflecting reviews of bolting and threaded fastener programs under new SRP Section 3.13 and edited the existing interface for compatibility.
21.	SRP-UDP format item	Revised review interface section of Areas of Review to be consistent with SRP-UDP required format which uses a number/paragraph format to distinguish individual reviews performed by other PRBs.

Item	Source	Description
22.	Potential Impact 25424	In response to an identified issue concerning the lack of explicit discussion in the SRP of reviews of the CRDS for compliance with GDC 4 requirements, this review interface was added reflecting reviews relating to design of the CRDS to accommodate accident environmental effects in accordance with the requirements of GDC 4.
23.	SRP-UDP format item	Revised to reflect the standard discussion of criteria and methods for reviews performed under other SRP sections.
24.	Current PRB names and abbreviations	Editorial change made to reflect current PRB names and responsibilities for SRP sections.
25.	SRP-UDP format item, Editorial	To avoid conflict with the numbering scheme used for specific criteria, revised to use a lettering scheme herein.
26.	Editorial	"Standard" in this usage should be plural "standards."
27.	Generic Issue B3 "Event Categorization"	Revised event categorizations and descriptions to be consistent with the CFRs and the GDCs which separate the terms anticipated operational occurrences and normal operation. This is consistent with the design of the CRDS which per GDCs 26, 27, and 29 shall be capable of controlling reactivity changes under conditions of normal operation, including anticipated operational occurrences and under postulated accident conditions.
28.	SRP-UDP format item, Editorial	Revised to reflect that references were renumbered in subsection VI as a result of added/deleted references and SRP-UDP format considerations relating to the order of the listing of references.
29.	SRP-UDP format item	The ASME Code is identified by reference number in a previous citation in the SRP section, therefore, identification by reference number at this location was deleted.
30.	SRP-UDP format item	The ASME Code is identified by reference number in a previous citation in the SRP section, therefore, identification by reference number at this location was deleted.
31.	SRP-UDP format item	The ASME Code is identified by reference number in a previous citation in the SRP section, therefore, identification by reference number at this location was deleted.

Item	Source	Description
32.	SRP-UDP format item, Editorial	Revised to spell out "Ref." Also revised to reflect that references were renumbered in subsection VI as a result of added/deleted references and SRP-UDP format considerations relating to the order of the listing of references.
33.	SRP-UDP format item, Editorial	Revised to spell out "Ref." Also revised to reflect that references were renumbered in subsection VI as a result of added/deleted references and SRP-UDP format considerations relating to the order of the listing of references.
34.	SRP-UDP format item, Editorial	Revised to spell out "Ref." Also revised to reflect that references were renumbered in subsection VI as a result of added/deleted references and SRP-UDP format considerations relating to the order of the listing of references.
35.	SRP-UDP format item, Editorial	Revised to spell out "Ref." Also revised to reflect that references were renumbered in subsection VI as a result of added/deleted references and SRP-UDP format considerations relating to the order of the listing of references.
36.	Editorial, Incorporation of PRB Comment	Revised title for consistency with subsection VI as recommended by the PRB.
37.	SRP-UDP format item, Editorial	Revised to spell out "Ref." Also revised to reflect that references were renumbered in subsection VI as a result of added/deleted references and SRP-UDP format considerations relating to the order of the listing of references.
38.	Editorial, Incorporation of PRB Comment	Revised title for consistency with subsection VI as recommended by the PRB.
39.	SRP-UDP format item, Editorial	Revised to spell out "Ref." Also revised to reflect that references were renumbered in subsection VI as a result of added/deleted references and SRP-UDP format considerations relating to the order of the listing of references.
40.	Editorial	Revised for consistency with the designation of this publication as listed in subsection VI, References.
41.	Editorial, Incorporation of PRB Comment	Revised title for consistency with subsection VI as recommended by the PRB.
42.	SRP-UDP format item, Editorial	Revised to spell out "Ref." Also revised to reflect that references were renumbered in subsection VI as a result of added/deleted references and SRP-UDP format considerations relating to the order of the listing of references.

Item	Source	Description
43.	SRP-UDP format item	The ASME Code is identified by reference number in a previous citation in the SRP section, therefore, identification by reference number at this location was deleted.
44.	SRP-UDP format item	SRP-UDP format does not list other SRP sections as references, thus the identification by reference number was deleted.
45.	SRP-UDP format item	SRP-UDP format does not list other SRP sections as references, thus the identification by reference number was replaced with direct citation of SRP Section 3.9.3.
46.	Editorial	Revised to clarify applicability to BWRs only, as also reflected in subsection V.
47.	SRP-UDP format item	Technical Rationale were developed and added for the following Acceptance Criteria: GDC 1 and 10 CFR 50.55a, GDCs 2, 14, 26, 27, and 29. The SRP-UDP program requires that Technical Rationale be developed for the Acceptance Criteria. Specific Technical Rationale were not developed for each individual accepted industry code and/or standard. Extensive supporting technical details are contained within the body of the associated codes and standards.
48.	Current PRB names and abbreviations	Editorial change made to reflect current PRB names and responsibilities for SRP Section 4.6.
49.	SRP-UDP format item	SRP-UDP format does not list other SRP sections as references, thus the identification by reference number was replaced with direct citation of SRP Section 3.9.3.
50.	SRP-UDP format item	SRP-UDP format does not list other SRP sections as references, thus the identification by reference number was replaced with direct citation of SRP Section 3.9.3.
51.	**Integrated Impact 935**	Added a further review procedure to address review of BWR CRDS scram discharge volume piping. The added procedure conservatively verifies use of design classifications and criteria which meets or exceeds the BWR Owner's Group criteria evaluated by the staff as the basis for its generic conclusions thus ensuring that the piping will also meet criteria described in SRP Section 3.6.2, BTP MEB 3-1 necessary for demonstrating that breaks and through wall cracks in the piping need not be postulated. The added procedure also verifies that adequate commitments are made regarding prevention and mitigation of the effects of leakage from the piping.

Item	Source	Description
52.	**Integrated Impact 1339**	Added further review procedures for review of the adequacy of BWR control rod drive return lines based on the staff's direction in Generic Letter 80-95 to implement NUREG-0619 positions which describe acceptable options associated with the design, inspection, testing, maintenance,and demonstration of overall control rod drive system operability related to the return lines.
53.	Editorial	Relocated to a more appropriate location at the end of the review procedures subsection since procedures other than procedure 2 may also involve evaluation of exceptions taken by the applicant.
54.	Current PRB names and abbreviations	Editorial change made to reflect current PRB names and responsibilities for SRP Section 4.5.1.
55.	SRP-UDP format item	The ASME Code is identified by reference number in a previous citation in the SRP section, therefore, identification by reference number at this location was deleted.
56.	SRP-UDP format item	SRP-UDP format does not list other SRP sections as references, thus the identification by reference number was replaced with direct citation of SRP Section 3.9.3.
57.	Generic Issue B3 "Event Categorization"	Revised event categorizations and descriptions to be consistent with the CFRs and the GDCs which separate the terms anticipated operational occurrences and normal operation. This is consistent with the design of the CRDS which per GDCs 26, 27, and 29 shall be capable of controlling reactivity changes under conditions of normal operation, including anticipated operational occurrences and under postulated accident conditions.
58.	Editorial, based upon Staff reviews described in evolutionary plant SERs	Chapter 4, Section 8.2 of the EPRI evolutionary light water reactor FSER included a list of plant conditions and criteria that the life cycle testing program must consider. One of these plant conditions is pressure tests. Therefore, to be consistent with current staff reviews on life cycle testing programs, pressure tests were added to the list in review procedure step 4.
59.	Editorial	Revised event categorizations and descriptions so that testing conditions are consistent with the conditions under which functionality is required in CFRs and the GDCs. Per GDCs 26, 27, and 29, the CRDS shall be capable of controlling reactivity changes under conditions of normal operation, including anticipated operational occurrences and under postulated accident conditions.

Item	Source	Description
60.	Editorial	Postulated accident condition in this usage should be plural, and was therefore changed to postulated accident conditions.
61.	Editorial, this item is a clarification based upon Staff reviews described in evolutionary plant SERs	Included in the list of plant conditions which the life cycle test program must consider for the advanced light water reactors is a distinction between operational scrams and test scrams. The SRP currently only discusses number of trips expected, this was clarified by specifying operational trips and test trips expected. This is consistent with current staff reviews on life cycle test programs described in the EPRI evolutionary plant FSER Chapter 4, Section 8.2.
62.	Editorial, this item is a clarification based upon Staff reviews described in evolutionary plant SERs	See discussion under previous note.
63.	Editorial	Relocated to reflect applicability to all preceding procedures, any of which may involve evaluation of exceptions taken by the applicant.
64.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
65.	Editorial	Revised to eliminate use of a gender-specific pronoun.
66.	Generic Issue B3 "Event Categorization"	Revised event categorizations and descriptions to be consistent with the CFRs and the GDCs which separate the terms anticipated operational occurrences and normal operation. This is consistent with the design of the CRDS which per GDCs 26, 27, and 29 shall be capable of controlling reactivity changes under conditions of normal operation, including anticipated operational occurrences and under postulated accident conditions.
67.	Editorial	Relocated to the end of the paragraph so that this BWR specific finding is discussed following findings which are applicable to both BWRs and PWRs rather than in the middle of such findings.
68.	Editorial	Revised to clarify applicability to BWRs only, as also indicated in subsection V.
69.	Editorial	Relocated to the end of the paragraph so that this BWR specific finding is discussed following findings which are applicable to both BWRs and PWRs rather than in the middle of such findings.
70.	SRP-UDP format item, Implementation of 10 CFR 52	Added the SRP-UDP standard description of additional items that should be discussed in the evaluation findings for design certification license reviews.

Item	Source	Description
71.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.
72.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
73.	**Integrated Impact 1339**, Editorial	Revised to reflect the existence of implementation information and schedules in References 11 and 12. Also revised to reflect that 10 CFR 50.55a contains implementation information/schedules.
74.	Editorial	Revised to improve grammar/clarity.
75.	SRP-UDP format item, reformat of Implementation information	Changed "revision" to "item" to clarify that operating plants and OL applicants are exempted from compliance with the provisions specified in the item, not necessarily from other provisions of the latest revision of the SRP section.
76.	SRP-UDP format item, reformat of Implementation information	Revised to reflect that applications (e.g., CP, OL, DC, COL) docketed after the 1984 revision of the SRP section need to comply with the specified provisions which were new in the 1984 revision. The existing reference specifically to CP applicants resulted in ambiguity regarding applicability of water hammer criteria to several other types of applicants whose applications were docketed after April, 1984 and was thus modified.
77.	SRP-UDP format item, reformat of Implementation information	Changed "revision" to "item" to clarify that applications docketed after the 1984 revision of the SRP section need to comply with the specified item since this paragraph is associated with a specified item.
78.	SRP-UDP format item	Added or deleted references so that only those required are listed in this subsection per SRP-UDP format. Also rearranged the listing/numbering to place the references in the order specified per the SRP-UDP format.
79.	SRP-UDP format item	Added listing for 10 CFR 50.55a since it is cited in this SRP section as acceptance criteria.
80.	Reference Verification	Added current full title for RG 1.26.
81.	Validation of References	Deleted reference to Regulatory Guide 1.48 which was withdrawn and is not referenced in the body of this SRP section. Regulatory Guide 1.48 was withdrawn and superseded by SRP Section 3.9.3 as indicated in a letter dated 3/1/85 from Robert B.Minogue of NRR.

Item	Source	Description
82.	SRP-UDP format item	Per SRP-UDP format, other SRP sections are not listed as references in subsection VI, therefore this listing for SRP Section 3.9.3 was deleted.
83.	**Integrated Impact 1339**	Added reference listing for NUREG-0619 which addresses acceptable options referenced in review procedures associated with the design, inspection, testing, maintenance,and demonstration of overall control rod drive system operability related to BWR control rod drive return lines.
84.	**Integrated Impact 1339**	Added reference listing for the Generic Letter which directs implementation of NUREG-0619, as referenced in review procedures associated with the design, inspection, testing, maintenance,and demonstration of overall control rod drive system operability related to BWR control rod drive return lines.
85.	**Integrated Impact 935**	Added a reference listing for Generic Letter 86-01 as it is referenced in review procedures for review of BWR CRDS scram discharge volume piping.
86.	Reference Verification	Revised to provide titles for major ASME Code sections referenced in this SRP section.
87.	**Integrated Impact # 350**, Validation of References	The latest version and title of this standard is ANSI/ASME B 16.5-1988, "Pipe Flanges and Flanged Fittings." Since NRC concurrence to update SRP standards citations has not been obtained, however, no changes to update citations of the standard were made under the SRP-UDP.
88.	**Integrated Impact # 350**, Validation of References	The latest version and title of this standard is ANSI/ASME B 16.9-1993, "Factory-Made Wrought Steel Buttwelding Fittings." Since NRC concurrence to update SRP standards citations has not been obtained, however, no changes to update citations of the standard were made under the SRP-UDP.
89.	**Integrated Impact # 350**, Validation of References	The latest version and title of this standard is ANSI/ASME B 16.11-1991, "Forged Fittings, Socket-Welding and Threaded." Since NRC concurrence to update SRP standards citations has not been obtained, however, no changes to update citations of the standard were made under the SRP-UDP.
90.	**Integrated Impact # 350**, Validation of References	The latest version and title of this standard is ANSI/ASME B 16.25-1992, "Buttwelding Ends." Since NRC concurrence to update SRP standards citations has not been obtained, however, no changes to update citations of the standard were made under the SRP-UDP.

Item	Source	Description
91.	**Integrated Impact # 350**, Validation of References	The latest version and title of this standard is ANSI/ASME B 16.34-1988, "Valves - Flanged and Welding End." Since NRC concurrence to update SRP standards citations has not been obtained, however, no changes to update citations of the standard were made under the SRP-UDP.
92.	**Integrated Impact # 350**, Validation of References	The latest version and title of this standard is ANSI/ASME B 31.1-1992, "Power Piping." Since NRC concurrence to update SRP standards citations has not been obtained, however, no changes to update citations of the standard were made under the SRP-UDP.
93.	Validation of References	The latest version and title of this standard is MSS-SP-25-1993, "Standard Marking System for Valves, Fittings, Flanges, and Unions." Since NRC concurrence to update SRP standards citations has not been obtained, however, no changes to update citations of the standard were made under the SRP-UDP.

Integrated Impact No.	Issue	SRP Subsections Affected
126	Add 60 Year Design Life Review Subsection - Not processed.	No changes made based on this ROC.
350	Revise references to specified ANSI/ASME standards to reflect latest versions and titles for the standards.	No changes made based on this ROC.
935	Add review of BWR scram discharge volume piping verifying the applicability of staff conclusions described in Generic Letter 86-01.	Review Procedures, subsection III.2 and References, subsection VI.13.
1339	Add review of BWR control rod drive systems which include a control rod drive return line, based on direction in Generic Letter 80-95 to implement staff positions in NUREG-0619.	Review Procedures, subsection III.2, Implementation subsection V, and References, subsections VI.11 and VI.12.