NUREG-0800
(Formerly NUREG-75/087)

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

6.3 EMERGENCY CORE COOLING SYSTEM

REVIEW RESPONSIBILITIES

Primary - Reactor Systems Branch (RSB)

Secondary - None

I. AREAS OF REVIEW

The RSB reviews the information presented in the applicant's safety analysis report (SAR) regarding the emergency core cooling system (ECCS). The major elements of the review are:

1. Design Bases

   The design bases for the ECCS are reviewed to assure that they satisfy applicable regulations, including the general design criteria and the amendments to 10 CFR Part 50 regarding ECCS acceptance criteria issued by the Commission on December 28, 1973 (Ref. 1).

2. Design

   The design of the ECCS is reviewed to determine that it is capable of performing all of the functions required by the design bases.

3. Test Program

   The preoperational and initial startup test programs for the ECCS are reviewed by the Procedures and Systems Review Branch (PSRB) to determine if they are sufficient to confirm the performance capability of the ECCS. RSB reviews the need for special design features to permit the performance of adequate test programs.

4. Technical Specifications

The proposed technical specifications are reviewed to assure that they are adequate in regard to limiting conditions of operation and periodic surveillance testing.

The ability of the ECCS to mitigate the consequences of a spectrum of loss-of-coolant accidents is reviewed by RSB under SRP Section 15.6.5.

In addition the RSB will coordinate with other branches evaluations that interface with the overall ECCS review as follows: Auxiliary Systems Branch (ASB), as part of its primary review responsibility for SRP Sections 9.2.1, 9.2.2, 9.2.5, and 9.2.6, reviews those auxiliary systems essential for ECCS operation (service water system, component cooling system, ultimate heat sink, and condensate storage facility) and assesses the capability of these systems to perform all functions required by the ECCS. The ASB will supply, on request, evaluations of portions of the power conversion systems (e.g., steam supply lines, steam generators, feedwater systems) which interface with the reactor coolant system in such a way as to influence the course of a loss-of-coolant accident (LOCA) for a particular plant. The ASB also reviews the effects of pipe breaks outside containment on ECCS. This review includes the effect of pipe whip, jet impingement forces, and environmental conditions created as part of its primary review responsibility for SRP Section 3.6.1. Instrumentation and Control Systems Branch (ICSB), as part of its primary review responsibility for SRP Section 7.3, reviews the adequacy of ECCS-associated controls and instrumentation with regard to the features of automatic actuation, remote sensing and indication, and remote control. The Containment Systems Branch (CSB) verifies that portions of the ECCS penetrating the containment barrier are designed with acceptable isolation features to maintain containment integrity for all operating conditions, including accidents, as part of its primary review responsibility for SRP Section 6.2.4. The Power Systems Branch (PSB) as part of its primary review responsibility for SRP Sections 8.1, 8.2, 8.3.1, and 8.3.2, reviews the adequacy of the power supply for the ECCS. The Mechanical Engineering Branch (MEB), as part of its primary review responsibility for SRP Section 3.9.3, reviews the loading combinations (operational, LOCA, and seismic) and the associated stress limits. In addition, the MEB, as part of its primary review responsibility for SRP Section 3.6.2, reviews the criteria used for postulating the effects of pipe breaks both inside and outside containment on ECCS. This review includes criteria used for postulating the effects of pipe whip, jet impingement forces, and any related environmental conditions. The ECCS is also reviewed by MEB to assure that system and components have the proper seismic and quality group classifications. This aspect of the review is performed as part of its primary review responsibility for SRP Sectons 3.2.1 and 3.2.2. The Structural and Geotechnical Engineering Branch (SGEB) reviews the structures housing the ECCS for the proper seismic classification as part of its primary review responsibility for SRP Sections 3.8.1, 3.8.2, and 3.8.3. The Materials Engineering Branch (MTEB), on a generic basis, reviews the thermal shock effect of water injected into the primary coolant system from the ECCS. The Procedures and Systems Review Branch (PSRB) reviews the proposed preoperational and initial startup test programs to determine that they are consistent with the intent of Regulatory

Guides 1.68 and 1.79 as part of its primary review responsibility for SRP Section 14.2.

The PSRB also has primary review responsibility for Task Action Plan items II.K.1 (C.1.10) of NUREG-0694 (OLs only) and I.C.6 of NUREG-0718 (CPs only) regarding procedures to ensure that system operability status is known. The Radiological Assessment Branch (RAB) has primary review responsibility for SRP Sections 12.1 through 12.5 including Task Action Plan items II.B.2 of NUREG-0694 and NUREG-0718 which involve radiation and shielding design review to take corrective actions to ensure adequate access to vital areas and protection of safety equipment (CPs and OLs). The review for Technical Specifications and Quality Assurance are coordinated and performed by the Standardization and Special Projects Branch and Quality Assurance Branch as part of their primary review responsibility for SRP Sections 16.0 and 17.0, respectively.

For those areas of review identified above as being reviewed as part of the primary review responsibility of other branches, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section of the corresponding primary branch.

II. ACCEPTANCE CRITERIA

The RSB acceptance criteria are based on meeting the relevant requirements of the following regulations:

A. General Design Criterion 2 as it relates to the seismic design of structures, systems, and components whose failure could cause an unacceptable reduction in the capability of the ECCS to perform its safety function. Acceptability is based on meeting position C2 of Regulatory Guide 1.29.

B. General Design Criterion 4 as related to dynamic effects associated with flow instabilities and loads (e.g., water hammer).

C. General Design Criterion 5 as it relates to structures, systems, and components important to safety shall not be shared among nuclear power units unless it can be demonstrated that sharing will not impair their ability to perform their safety function.

D. General Design Criterion 17 as it relates to the design of the ECCS having sufficient capacity and capability to assure that specified acceptable fuel design limits and the design conditions of the reactor coolant pressure boundary are not exceeded and that the core is cooled during anticipated operational occurrences and accident conditions.

E. General Design Criterion 27 as it relates to the system design having the capability to assure that under postulated accident conditions and with appropriate margin for stuck rods, the capability to cool the core is maintained.

F. General Design Criteria 35, 36, and 37 as they relate to the ECCS being designed to provide an abundance of core cooling to transfer heat from the core at a rate so that fuel and clad damage will not interfere with continued effective core cooling, to permit appropriate periodic inspection of important components, and to permit appropriate periodic pressure and functional testing.

G. 10 CFR Part 50, §50.46, and Appendix K to 10 CFR Part 50 as it relates to the ECCS being designed so that its cooling performance is in accordance with an acceptable evaluation model.

Specific acceptance criteria, Regulatory Guides, and Task Action Plan items that provide information, recommendations, and guidance and in general describe a basis acceptable to the staff that may be used to implement the requirements of the Commission regulations identified above are as follows:

In regard to the ECCS acceptance criteria (Ref. 1), the five major performance criteria deal with:

1. Peak cladding temperature.
2. Maximum calculated cladding oxidation.
3. Maximum hydrogen generation.
4. Coolable core geometry.
5. Long-term cooling.

These areas are reviewed as a part of the effort associated with the LOCA analysis (SRP Section 15.6.5). However, the impact of various postulated single failures on the operability of the ECCS is evaluated under this SRP section.

The ECCS must meet the requirements of GDC 35 (Ref. 6). The system must have alternate sources of electric power, as required by GDC 17 (Ref. 4), and must be able to withstand a single failure. The ECCS should retain its capability to cool the core in the event of a failure of any single active component during the short term immediately following an accident, or a single active or passive failure during the long-term recirculation cooling phase following an accident.

The ECCS must be designed to permit periodic inservice inspection of important components, such as spray rings in the reactor pressure vessel, water injection nozzles, piping, pumps, and valves in accordance with the requirements of GDC 36 (Ref. 7). The ECCS must be designed to permit testing of the operability of the system throughout the life of the plant, including the full operational sequence that brings the system into operation, as required by GDC 37 (Ref. 8).

The combined reactivity control system capability associated with ECCS must meet the requirements of GDC 27 (Ref. 5) and should conform to the recommendation of Regulatory Guide 1.47 (Ref. 11). The primary mode of actuation for the ECCS must be automatic, and actuation must be initiated by signals of suitable diversity and redundance. Provisions should also be made for manual actuation, monitoring, and control of the ECCS from the reactor control room.

The design of the ECCS should conform to the recommendations of Regulatory Guide 1.1 (Ref. 9).

Design features and operating procedures, designed to prevent damaging water hammer due to such mechanisms as voided discharge lines and water entrainment in steam lines shall be provided, in order to meet the requirements of General Design Criterion 4 (Ref. 17).

The design of those portions of the system which are not safety related, whose failures could have an adverse effect on the ECCS system, must be in accordance with GDC 2 (Ref. 2), and acceptance is based on meeting Position C2 of Regulatory Guide 1.29 (Ref. 10).

Interfaces between the ECCS and component or service water systems must be such that operation of one does not interfere with, and provides proper support (where required) for, the other. In relation to these and other shared systems, e.g., residual heat removal (RHR) and containment heat removal systems, the ECCS must conform to GDC 5 (Ref. 3).

The requirements of the following Task Action Plan items must also be satisfied:

1. Task Action Plan Item II.B.8 of NUREG-0718 (Ref. 14) which involves description by the applicants of the degree to which the designs conform to the proposed interim rule on degraded core accidents (CPs and OLs).

2. Task Action Plan Item III.D.1.1 of NUREG-0694 and NUREG-0718 which involves primary coolant sources outside of containment (CPs and OLs).

3. Task Action Plan Item II.E.2.1 of NUREG-0737 which involves reliance on ECCS.

4. Task Action Plan Item II.K.3(10) of NUREG-0737 and NUREG-0718 which involves final recommendations by B&O task force regarding applicant's proposal of use of anticipatory trips only at high power for selected plants.

5. Task Action Plan Item II.K.3(15) of NUREG-0737 and NUREG-0718 which involves isolation of HPCI and RCIC for BWR plants.

6. Task Action Plan Item II.K.3(18) of NUREG-0737 and NUREG-0718 involving ECCS outages for all plants.

7. Task Action Plan Item II.K.3(21) of NUREG-0737 and NUREG-0718 which involves a study evaluating restart of LPCS and LPCI after manual trip for BWR plants.

8. Task Action Plan Item II.K.3(39) of NUREG-0660 which involves evaluation of effects of water slugs in piping caused by HPI and CFT flows in B&W plants.

In addition to the above criteria, the acceptability of the ECCS may be based on the degree of design similarity with previously approved plants.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to assure that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II of this SRP section.

For operating license (OL) reviews, the procedures are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The OL review also includes the proposed technical specifications to assure that they are adequate in regard to limiting conditions of operation and periodic surveillance testing.

Much of the review described below is generic in nature and is not performed for each plant. That is, the RSB reviewer compares the ECCS design and parameters to those of previously reviewed plants and then devotes the major portion of the review effort to those areas where the application is not identical to previously reviewed plants. The following steps are taken by the RSB reviewer to determine that the acceptance criteria of subsection II have been met. These steps should be adapted to CP or OL reviews as appropriate.

1. The relationship of the system under review to other previously approved plants is established. Systems or design features claimed to be identical or equivalent to those of previously approved plants are confirmed to be identical or equivalent.

2. Piping diagrams are reviewed to evaluate the functional reliability of the system in the event of single failures. That is, by referring to piping and instrumentation diagrams, the existence of the redundancy required by the criteria is confirmed.

3. The significant design parameters (e.g., pump net positive suction head, pump head vs. flow, accumulator volume and pressure, water storage volume, system flow rate and pressure, etc.) are examined for each component to confirm that these parameters satisfy operating requirements and the recommendations of Regulatory Guide 1.1 (Ref. 9).

4. The piping and instrumentation diagrams are checked in consultation with MEB to see that essential ECCS components are designated seismic Category I and Safety Class II (the cooling water side of heat exchangers can be Safety Class III).

5. The ECCS design is reviewed to confirm that the system can function in postaccident environments, considering possible mechanical effects, missiles, and the pressure, temperature, moisture, radioactivity, and chemical conditions resulting from LOCA. Protection against valve motor flooding should be confirmed by the RSB reviewer. Regarding the effects of pressure, temperature, etc., the RSB reviewer should confirm that accident conditions are specified which provide the basis for proof tests for environmental qualification of ECCS components.

6. The criteria, supporting analyses, plant design provisions, and operator actions that will be taken are reviewed to ensure that there will not be unacceptably high concentrations of boric acid in the core region (resulting in precipitation of a solid phase) during the long-term cooling phase following a postulated LOCA.

7. The ECCS design is reviewed to confirm that there are provisions for maintenance of the long-term coolant recirculation and decay heat removal systems, e.g., pump or valve overhaul, in the post-LOCA environment (including consideration of radioactivity).

8. The availability of an adequate source of water for the ECCS is confirmed, and the source volume, location, and susceptibility to failure (e.g., freezing) are evaluated. (RSB will request ASB review as required.) In PWRs, the piping from the water source to the ECCS safety injection pumps is evaluated for conformance with RSB 6-1 (Ref. 13).

9. The ECCS flow paths are reviewed to determine the extent to which flow from the ECCS pumps is diverted as a backup feature to other safeguards equipment (e.g., RHR, containment spray). The reviewer should confirm that the remaining portion of the flow provides abundant core cooling, despite the most severe single failure that affects ECCS flow.

10. For a boiling water reactor (BWR), the reactor coolant automatic depressurization system is reviewed to confirm the capability to satisfy LOCA pressure relief functions, including consideration of a single failure.

11. The design of ECCS injection lines is reviewed to confirm that the isolation provisions at the interface with the reactor coolant system are adequate. The number and type of valves used to form the interface between low pressure portions of the ECCS and the reactor coolant system must provide adequate assurance that the ECCS will not be subjected to a pressure greater than its design pressure. This may be accomplished by any of the following provisions:

    a. One or more check valves in series with a normally closed motor-operated valve. The motor-operated valve is to be opened upon receipt of a safety injection signal once the reactor coolant pressure has decreased below the ECCS design pressure.

    b. Three check valves in series.

    c. Two check valves in series, provided that there are design provisions to permit periodic testing of the check valves for leaktightness and the testing is performed at least annually.

12. The reviewer should identify those portions of nonsafety-related systems which could have an adverse effect on ECCS and should ensure that modifications are in place to correct these situations.

13. Motor-operated isolation valves in ECCS lines connecting the accumulators to the reactor coolant system in a pressurized water reactor (PWR) are reviewed to ensure that adequate provisions are made against inadvertent isolation.

14. The capacity and settings of relief valves provided for the ECCS to satisfy system overpressure protection requirements are reviewed. In particular, for PWRs, the reviewer confirms that the accumulator relief

valves have adequate capacity so that leakage from the reactor coolant system will not jeopardize the integrity of the accumulators.

15. The ECCS is reviewed to evaluate the adequacy of design features that have been provided to prevent damaging water (steam) hammer due to such mechanisms as voided discharge lines, water entrainment in steam lines and steam bubble collapse. For systems with a water supply above the discharge lines, voided lines are prevented by proper vent location and filling and venting procedures. However, for the core spray and low pressure coolant injection systems of BWRs, the low elevation of the suppression pool will result in line voidage because of back leakage through pump discharge check valves and leaking valves in the full flow test line. Proper vent location and filling and venting procedure are still needed. In addition, a special keep-full system with appropriate alarms is needed to supply water to the discharge lines for any system which has a water source below the level of the highest pump discharge lines and at sufficiently high pressure to prevent voiding.

    For the High Pressure Coolant Injection (HPCI) system of BWRs which uses a steam-driven turbine, typical design features for the steam supply line include (a) drain pots with testable drain pot level switches, (b) sloped lines, and (c) limitations on opening and closing sequences and seal-ins for manual operation of the isolation valves to prevent introducing water slugs into the line. The turbine exhaust line features include sloped lines and vacuum breakers.

16. The reviewer confirms that no component or feature of the ECCS in one reactor facility on a multiple plant site is shared with the ECCS in another facility, or that shared features clearly meet the requirements of GDC 5 (Ref. 3).

17. The reviewer confirms that within an individual reactor facility, any components shared between the ECCS and other systems (e.g., coolant makeup systems, residual heat removal systems, containment cooling systems) satisfy engineered safeguard feature design requirements and that the ECCS function of the shared component is not diminished by the sharing.

18. The reviewer confirms that ECCS components located exterior to the reactor containment are housed in a structure which, in the event of leakage from the ECCS, permits venting of releases through iodine filters designed in accordance with Regulatory Guide 1.52.

19. The complete sequence of ECCS operation from accident occurrence through long-term core cooling is examined to see that a minimum of manual action is required and, where manual action is used, a sufficient time (greater than 20 minutes) is available for the operator to respond.

20. The reviewer confirms that long-term cooling capacity is adequate in the event of failure of any single active or passive component of the ECCS. If an intermediate heat transport system, such as the component cooling water system, is used to provide long-term cooling capability, the system must be designed and constructed to an appropriate group classification, must be seismic Category I, and must be capable of sustaining a single active or passive failure without loss of function.

21. The RSB reviewer consults with the ICSB reviewer to:

    a. Confirm that the power requirements of the ECCS, including the timing of electrical loads, are compatible with the design of onsite emergency power systems, both a-c and d-c.

    b. Confirm that there are sufficient instrumentation and controls available to the reactor operator to provide adequate information in the control room to assist in assessing post-LOCA conditions, including the more significant parameters such as coolant flow, coolant temperature, and containment pressure. If ECCS flow is diverted as a backup to other safeguards systems, the reviewer confirms that instrumentation and controls are available to provide sufficient information in the control room to determine that adequate core cooling is being provided.

    c. Confirm that automatic actuation and remote-manual valve controls are capable of performing the functions required, that suitable interlocks are provided, which do not impair separation of power trains or inhibit the required valve motions, and that instrumentation and controls have sufficient redundancy to satisfy the single failure criterion.

22. Analyses are provided by the applicant in Chapter 15 of the SAR to assess the capability of the ECCS to meet functional requirements. These analyses are reviewed by the RSB, as described in SRP Section 15.6.5, to determine conformance to the acceptance criteria for ECCS. However, the following portions of the review of ECCS response in loss-of-coolant accidents are performed by the RSB reviewer under this SRP section:

    a. The lower limit of break size for which ECCS operation is required is established; i.e., the maximum break size for which normal reactor coolant makeup systems can maintain reactor pressure and coolant level is determined. The capability of the ECCS to actuate and perform at this lower limit of break size is confirmed.

    b. The reviewer confirms that the analyses take into account a variety of potential locations for postulated pipe breaks, including ECCS injection lines.

    c. The reviewer confirms that the analyses take into account a variety of single active failures. The reviewer should keep in mind that different single failures may be limiting, depending on the particular break location and break size postulated.

    d. The ECCS component response times (e.g., for valves, pumps, power supply) are reviewed to confirm that they are within the delay times used in the accident analyses.

    e. The ECCS design adequacy for all modes of reactor operation (e.g., full power, low power, hot standby, cold shutdown, partial loop isolation) is confirmed.

23. The proposed plant technical specifications are reviewed to:

a. Confirm the suitability of the limiting conditions of operation, including the proposed time limits and reactor operating restrictions for periods when ECCS equipment is inoperable due to repairs and maintenance. The means of indicating that safety systems have been bypassed or are inoperable should be in accordance with Regulatory Guide 1.47 (Ref. 11).

b. Confirm that the limiting conditions of operation ensure that the specified operating parameters (minimum poison concentrations, minimum coolant reserve in storage, etc.) are within the bounds of the analyzed conditions.

c. Verify that the frequency and scope of periodic surveillance testing is adequate.

24. The reviewer confirms that the design provides the capability for periodically demonstrating that the system will operate properly when an accident signal is received. That is, it should be demonstrated by an applicant that pumps and valves operate on normal and emergency power and that water pressure and flow are as designed when the plant is operating (periodic system surveillance). When the plant is shut down for refueling, the system should be tested for delivery of coolant to the vessel.

25. The RSB reviewer contacts his counterpart in PSRB to discuss any special test requirements and to confirm that the proposed preoperational test program for the ECCS is in conformance with the intent of Regulatory Guide 1.68 (Ref. 12).

26. The RSB review evaluates the applicant responses to the following Task Action Plan items:

(a) II.B.8 of NUREG-0718 (CPs only)
(b) III.D.1.1 of NUREG-0737 and NUREG-0718 (CPs and OLs)
(c) II.E.2.1 of NUREG-0660
(d) II.K.3(10) of NUREG-0660
(e) II.K.3(15) of NUREG-0660
(f) II.K.3(18) of NUREG-0660
(g) II.K.3(21) of NUREG-0660
(h) II.K.3(39) of NUREG-0660

IV. EVALUATION FINDINGS

The reviewer verifies that the SAR contains sufficient information and his review supports the following kinds of statements and conclusions which should be included in the staff's safety evaluation report. (For completeness, this evaluation finding includes the RSB review effort described in SRP Section 15.6.5.)

The emergency core cooling system (ECCS) includes the piping, valves, pumps, heat exchangers, instrumentation, and controls used to transfer heat from the core following a loss-of-coolant accident. The scope of review of the ECCS for the ___________ plant included piping and instrumentation diagrams, equipment layout drawings, failure modes and effects analyses, and design specifications for essential components. The review has included the applicant's proposed design criteria and design bases for the ECCS and the manner in which the design conforms to these criteria and bases.

The staff concludes that the design of the Emergency Core Cooling System is acceptable and meets the requirements of General Design Criteria 2, 4, 5, 17, 27, 35, 36, and 37. This conclusion is based on the following:

(1) The applicant has met the requirements of GDC 2 with regard to the seismic design of nonsafety systems or portions thereof which could have an adverse effect on ECCS by meeting position C.2 of Regulatory Guide 1.29.

(2) The applicant has met the requirements of GDC 4 as related to dynamic effects associated with flow instabilities and loads (e.g., water hammer).

(3) The applicant has met the requirements of GDC 5 with respect to sharing of structures, systems, and components by demonstrating that such sharing does not significantly impair the ability of the ECCS to perform its safety function including, in the event of an accident to one unit, an orderly shutdown and cooldown of the remaining units.

(4) The applicant has met the requirements of GDC 17 with regard to providing sufficient capacity and capability to assure that (a) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (b) the core is cooled and vital functions are maintained in the event of postulated accidents.

(5) The applicant has met the requirements of GDC 27 with regard to providing combined reactivity control system capability to assure that under postulated accident conditions and with appropriate margin for stuck rods the capability to cool the core is maintained and the applicant's design meets the guidelines of Regulatory Guide 1.47.

(6) The applicant has met the requirements of GDC 35 to provide abundant cooling for ECCS by providing redundant safety-grade systems that meet the recommendations of Regulatory Guide 1.1.

(7) The applicant has met the requirements of GDC 36 with respect to the design of ECCS to permit appropriate periodic inspection of important components of the system.

(8) The applicant has met the requirements of GDC 37 with respect to designing the ECCS to permit testing of the operability of the system throughout the life of the plant, including the full operational sequence that brings the system into operation.

(9) The applicant has provided an analysis of the proposed ECCS relative to the acceptance criteria of 10 CFR Part 50, §50.46, and Appendix K to demonstrate that their ECCS designs for peak cladding temperature, maximum calculated cladding oxidation, maximum hydrogen generation, coolable core geometry, and long-term cooling are in accordance with the acceptable evaluation model.

In addition, the applicant has met the requirements of the following Task Action Plan items:

(1) Meeting Task Action Plan item II.B.8 of NUREG-0718 (Ref. 14) which involves description by the applicants of the degree to which the designs conform to the proposed interim rule on degraded core accidents (CPs only).

(2) Meeting Task Action Plan item II.D.1.1 of NUREG-0737 (Ref. 15) and NUREG-0718 (Ref. 14) which involves primary coolant sources outside of containment (CPs and OLs).

(3) Meeting Task Action Plan item II.E.2.1 of NUREG-0660 (Ref. 16) which involves reliance on ECCS.

(4) Meeting Task Action Plan item II.K.3(10) of NUREG-0660 which involves applicant's proposal to limit anticipatory trip to high power for selected plants.

(5) Meeting Task Action Plan item II.K.3(15) of NUREG-0660 which involves isolation of HPCI and RCIC for BWR plants.

(6) Meeting Task Action Plan item II.K.3(18) of NUREG-0660 which involves ECCS outages for all plants.

(7) Meeting Task Action Plan item II.K.3(21) of NUREG-0660 which involves restart of LPCS and LPCI for BWR plants.

(8) Meeting Task Action Plan item II.K.3(3a) of NUREG-0660 which involves evaluation of effects of water slugs in piping caused by HPI and CFT flows in B&W plants.

V. IMPLEMENTATION

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

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.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides, NUREGs, BTP RSB 6-1 and implementation of acceptance criterion subsection II.B is as follows:

(a) Operating plants and OL applicants need not comply with the provisions of this revision.

(b) CP applicants will be required to comply with the provisions of this revision.

VI. REFERENCES

1. 10 CFR Part 50, §50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water-Cooled Nuclear Power Reactors," and Appendix K to 10 CFR Part 50, "ECCS Evaluation Models," issued by the Commission December 28, 1973; Federal Register, Vol. 39, No. 3, January 4, 1974.

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

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. 10 CFR Part 50, Appendix A, General Design Criterion 17, "Electric Power Systems."

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

6. 10 CFR Part 50, Appendix A, General Design Criterion 35, "Emergency Core Cooling."

7. 10 CFR Part 50, Appendix A, General Design Criterion 36, "Inspection of Emergency Core Cooling System."

8. 10 CFR Part 50, Appendix A, General Design Criterion 37, "Testing of Emergency Core Cooling System."

9. Regulatory Guide 1.1, "Net Position Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps."

10. Regulatory Guide 1.29, "Seismic Design Classification," Revision 1.

11. Regulatory Guide 1.47, "Bypass and Inoperable Status Indication for Nuclear Power Plant Safety Systems."

12. Regulatory Guide 1.52, "Design, Testing, and Maintenance Criteria for Atmospheric Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."

13. Regulatory Guide 1.68, "Preoperational and Initial Startup Test Programs for Water-Cooled Power Reactors."

14. Branch Technical Position RSB 6-1, "Piping From the RWST (or BWST) and Containment Sump(s) to the Safety Injection Pumps," attached to SRP Section 6.3.

15. NUREG-0718, "Licensing Requirements for Pending Applications for Construction Permits and Manufacturing Licenses."

16. NUREG-0737, "Clarification of TMI Action Plan Requirements."

17. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Basis."

BRANCH TECHNICAL POSITION RSB 6-1

PIPING FROM THE RWST (OR BWST) AND CONTAINMENT SUMP(S) TO THE SAFETY INJECTION PUMPS

A. Background

Current PWRs utilize the refueling water storage tank (RWST) or the borated water storage tank (BWST) as the sole source of water for the safety injection pumps during the first 20 to 40 minutes of any accident that trips a safety injection signal. Since acceptable results of safety analyses of the accidents are based on the operation of a minimum number of these pumps, interruption of this water supply for even a short period of time could result in unacceptably high fuel and cladding temperatures if the safety injection pumps fail because of cavitation or overheating.

General Design Criteria 35 requires that the emergency core cooling system have suitable redundancy in components and features and suitable interconnections to assure the system safety function can be accomplished assuming a single failure. The principal problem appears to be a definition of single failure. A recent draft of ANSI N658, "Single Failure Criteria for PWR Fluid Systems," defines an active failure as:

(a) "An active failure is a malfunction, exceeding passive failures, of a component which relies on mechanical movement to complete its intended function upon demand."

(b) "Spurious action of a powered component originating within its actuation system shall be regarded as an active failure unless specific design features or operating restrictions preclude such spurious action."

This branch position on the availability of the RWST is based on the above criteria and the recognition that water supplied from the RWST system to the ECCS system is absolutely essential in the event of a LOCA.

B. Branch Position

1. The single active failure criterion defined in (a) and (b) above will be applied in evaluating the design of the piping systems that connect the safety injection pumps to the RWST (BWST) and the containment sumps.

2. The piping systems, including valves, shall be designed to satisfy the requirements listed below without the need to disconnect the power to any valve.

3. The valves and piping between the RWST (or BWST) and the safety injection pumps must be arranged so that no single failure will prevent the minimum flow to the core required to satisfy 10 CFR Part 50, §50.46.

4. The valves and piping between the RWST (or BWST) and safety injection pumps must be arranged so that no single active failure will result in damage to pumps such that the minimum flow requirements for long-term core and containment cooling after a LOCA are not satisfied.

5. The valves and piping that connect the RWST (or BWST) and the containment sumps(s) to the safety injection pumps must be arranged so as not to preclude automatic switchover from the injection mode of ECCS operation to recirculation cooling from the sump. These piping systems must be arranged so that the differential pressure between the sump and the RWST (or BWST), even if there is a single active failure, will not result in a loss of core cooling or a path that permits release of radioactive material from the containment to the environment.

C. Implementation

1. CPs Under Review and Future CP Reviews

The proposed position will be applied to all CP reviews for which an SER was not published prior to April 16, 1975. It is expected that all of the events of the proposed position will be applied for such reviews. Taking this position on CPs would eliminate the need for various schemes such as locking out power to valves located in the line between the various ECCS pumps and refueling water storage tank.

2. OLs Under Review

For operating licenses that are presently under review and OLs to be reviewed in the future that are not covered by item 1, the proposed position will not be completely applied. Specifically, locking out power to valves will be permitted. For most plants it is expected that this will be sufficient to meet the single failure criteria. However, in other plants changes to the piping and valving arrangements may be required to satisfy the single failure criteria.

3. Plants Under Construction

These plants will be handled as discussed in item C.2. It is expected, however, that we will discuss the proposed position with each of the applicable PWR vendors. It will be obvious to the vendors which plants now under construction may have a problem. Then a generic review may be conducted for those plants that have a severe problem.

4. Operating Plants

All of the operating plants are being evaluated as an ongoing part of the current ECC review. The review should be conducted as discussed in item C.2 to assure that these plants meet the essential parts of the proposed position.