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U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 5.4.8 REACTOR WATER CLEANUP SYSTEM (BWR)

REVIEW RESPONSIBILITIES

Primary Effluent Treatment Systems Branch (ETSB)

Secondary - Auxiliary Power and Conversion Systems Branch (APCSB)
Reactor Systems Branch (RSB)
Electrical, Instrumentation and Control Systems Branch (EICSB)
Materials Engineering Branch (MTEB)

I. AREAS OF REVIEW

At the construction permit (CP) stage of review, ETSB reviews the information in the applicant's safety analysis report (SAR) in the specific areas that follow. At the operating license (OL) stage of review, the ETSB review consists of confirming the design accepted at the CP stage and evaluating the adequacy of the applicant's technical specifications in these areas.

1. The design of components, design features which influence system availability and reliability, and interconnections with the reactor primary coolant and radwaste systems are reviewed. Fission product removal by the reactor water cleanup system (RWCS) is considered under Standard Review Plan (SRP) 11.2. The provisions for isolating the RWCS from the reactor system following liquid poison injection, holding filter and demineralizer beds in place if system flow is decreased, straining resins from return flows to the primary system, component venting, and resin transfer are reviewed.

2. The component design parameters for flow, temperature, pressure, heat removal capability, and impurity removal capability to assure the system capacity will meet the reactor coolant specifications are reviewed.

3. The quality group and seismic design criteria are reviewed.

4. The instrumentation and process controls provided to ensure proper system operation and system isolation when necessary, including instrumentation for (a) automatic system isolation to prevent removal of liquid poison in the event of standby liquid control system actuation and to prevent damage to the filter demineralizer resins, and (b) monitoring impurity removal (conductivity measurements), differential pressure across pressure-sensitive components, and temperature control prior to demineralization, are reviewed. In addition, the process controls responding to these measurements to maintain operation within the established system parameters are reviewed.

Secondary reviews are provided as follows: (a) APCSB reviews the system design for pipe breaks that could incapacitate safety-related equipment. APCSB also reviews the physical separation which is provided between system components and piping to protect essential portions of the system from missiles, pipe whip, and jet impingement that may result from piping breaks. This system is normally inside containment, but the criteria for line breaks outside containment are applied to it (SRP 3.5.1); (b) MTEB reviews the material properties and the inservice inspection requirements of the portions of the system that comprise the reactor coolant pressure boundary (SRP 5.2.3); (c) EICSB reviews instrumentation, components, and power sources with respect to their capacities, capabilities, reliability, and conformance to acceptance standards (SRP 7.6); (d) RSB reviews the system drawings of portions of the RWCS that are part of the reactor coolant pressure boundary for correct identification and for capability for isolation from the remainder of the system. RSB evaluates isolation valve performance and verifies that two automatically operated isolation valves in series, or one automatically operated isolation valve and one check valve in series, or one automatically operated isolation valve and one check valve in series, physically separate essential from nonessential portions of the system. RSB also verifies that sufficient instrumentation and controls have been provided to permit plant operators to diagnose and correct system failures that could impair the condition of engineered safety features.

II. ACCEPTANCE CRITERIA

The ETSB will accept the reactor water cleanup system design if the following criteria are met:

1. The reactor water cleanup system should include the following:
    a. Provisions for automatically isolating the RWCS from the reactor primary coolant system in the event the liquid poison system is actuated for reactor shutdown.
    b. Provisions for automatically isolating the RWCS in the event the nonregenerative heat exchanger effluent temperature exceeds the prescribed resin operating temperature for the cleanup demineralizer resins.
    c. Means for automatically maintaining flow through filter demineralizer beds in the event of low process flow or loss of process flow through the system, to prevent bed loss. The recirculation loop and holding pump subsystem provided for precoating can serve this purpose if it is activated on loss of flow or low flow conditions.
    d. Means of transferring resins. Sight glass provisions (bull's eyes) are acceptable for monitoring resin transfers. Systems should be designed to prevent "resin traps" in sluice lines. A statement indicating that consideration will be given in the design to avoid resin traps, e.g., a statement that resin transfer lines will be designed to avoid resins collecting in valves, low points, or stagnant areas, will be acceptable for transfer line designs.
    e. Provisions for venting RWCS components through a closed system, i.e., not to the immediate atmosphere. The SAR should state that vent lines run to a ventilation duct exhausting from the plant.
    f. Provision, in return lines to the reactor system or condensate system, of resin strainers capable of removing resin particles contained in demineralizer effluents.

2. The system should be capable of maintaining acceptable reactor water purity in normal operation and during anticipated operational occurrences, e.g., reactor startup, refueling, and condensate demineralizer breakthrough. The following points should be included in the system design:
   a. The system should be designed to maintain reactor water purity within the guide lines of Regulatory Guide 1.56. The system should provide demineralization of reactor water through mixed bed nuclear grade resins (beads or powdered) at approximately 1% of the main steam flow rate.
   b. The non-regenerative heat exchangers should be designed to reduce the cleanup flow temperature to the demineralizer operating temperature without the aid of the regenerative heat exchangers.
   c. The RWCS capacity should be sufficient to permit processing of surplus refueling water prior to storage in refueling water storage tanks or condensate storage tanks. Interconnections between the reactor water cleanup and liquid water systems to share the processing burden are acceptable.
   d. The RWCS should be designed to permit processing of reactor water during periods of single component failures or equipment downtime.

3. To meet the guidelines of Regulatory Guides 1.26 and 1.29, the portion of the RWCS extending from the reactor vessel and recirculation loops to the outermost drywell isolation valves should be designed to seismic Category I and Quality Group A. The remainder of the system should be designed to Quality Group C and need not be seismic Category I.

4. The RWCS should include provisions for monitoring:
   a. System effluent conductivity. Instrumentation should be consistent with Regulatory Guide 1.56.
   b. Temperature upstream of the demineralizer, to assure the ion exchange resin temperature limits are not exceeded.
   c. Differential pressure, to assure the design limits on filter/demineralizer septums and resin strainers are not exceeded.

III. REVIEW PROCEDURES

The reviewer will select and emphasize material from this review plan, as may be appropriate for a particular case.

1. ETSB reviews the system description and piping and instrumentation diagrams (P&IDs) to determine the processing sequence, interconnections with other systems, and similarity to systems previously evaluated, and establishes that the following are considered in the applicant's design:
   a. Provisions to automatically terminate flow to the RWCS following liquid poison injection into the reactor water.
   b. Provisions to automatically terminate flow to the cleanup demineralizers if the non-regenerative heat exchanger effluent temperature exceeds the resin operating temperature limits.

c. Provisions for automatically maintaining flow through filter/demineralizer units in the event system flow decreases to a point where the bed may drop from the septum.

d. Provisions for monitoring resin transfers to assure transfers are complete and design considerations are incorporated to eliminate resin traps.

e. Provisions for venting cleanup system components during drain, fill, and air mixing operations.

f. Provisions for removing resin particles from cleanup system product water to prevent resins from entering the reactor system.

2. ETSB reviews the system capacity and processing flexibility and considers the following:

a. The process equipment, resin types, and bed volumes compared to those for similar reactors and the RWCS capability compared to the guidelines of Regulatory Guide 1.56.

b. The design flows and temperatures through the system to assure the criteria for outlet temperature relative to resin temperature are met.

c. The RWCS capability to process surplus refueling water prior to storage in the refueling water storage tanks or the condensate storage tanks. The system flow rate, surplus capacity in the liquid radwaste system if interconnections exist, and the volume of water to be processed to assure the wastes could be processed in a time which is consistent with the plant requirements, are considered.

d. Redundant or parallel components which will permit cleanup, if required, during periods of equipment downtime or single component failures.

3. In the review of the quality group and seismic design classification of the system, ETSB compares the design to the guidelines of Regulatory Guides 1.26 and 1.29. In particular, the portion of the RWCS extending from the reactor vessel and recirculation loops to the outermost drywell isolation valves is reviewed to assure conformance to seismic Category I and Quality Group A.

4. ETSB reviews the instrumentation and controls for the reactor water cleanup system to assure that monitors are provided for:

a. Conductivity of demineralizer effluent.

b. Temperature and conductivity of demineralizer influent.

c. Differential pressure across the demineralizer and across the resin strainers.

ETSB assures that system controls are responsive to the monitor indications to maintain the required temperature and flow and that conductivity meters cover the entire range up to mandatory shutdown as delineated in the plant technical specifications in the final safety analysis report (FSAR).

IV. EVALUATION FINDINGS

ETSB verifies that sufficient information has been provided and that the review is adequate to support conclusions of the following type, to be included in the staff's safety evaluation report:

"The reactor water cleanup system (RWCS) will be used to aid in maintaining the reactor water purity and to reduce the reactor water inventory as required by plant operations. The scope of the review of the RWCS includes the system capability to meet the anticipated needs of the plant, the capability of the instrumentation and process controls to ensure operation within limits defined in Regulatory Guide 1.56, and the seismic design and quality group classifications contained in Regulatory Guides 1.26 and 1.29. Our review has included piping and instrumentation diagrams and process diagrams along with descriptive information concerning the system design and operation.

"The basis for acceptance in our review has been conformance of the applicant's designs and design criteria to the Commission's regulations and to applicable regulatory guides, as referenced above, as well as to staff technical positions and industry standards.

"Based on the foregoing evaluation, we conclude that the proposed reactor water cleanup system is acceptable."

V. REFERENCES

1. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Revision 2.

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

3. Regulatory Guide 1.56, "Maintenance of Water Purity in Boiling Water Reactors."

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SRP 5.4.11