U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 11.2 LIQUID WASTE MANAGEMENT SYSTEMS

REVIEW RESPONSIBILITIES

Primary - Effluent Treatment Systems Branch (ETSB)

Secondary - Radiological Assessment Branch (RAB)
Structural Engineering Branch (SEB)

I. AREAS OF REVIEW

At the construction permit (CP) stage, ETSB reviews the information in the applicant's preliminary safety analysis report (PSAR) in the specific areas that follow. During the operating license (OL) stage of review, 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 liquid radwaste treatment system design, design objectives, design criteria, methods of treatment, expected releases, and principal parameters used in calculating the releases of radioactive materials in liquid effluents. The ETSB review will include the system piping and instrumentation diagrams (P&IDs), and process flow diagrams showing methods of operation and factors that influence waste treatment, e.g., system interfaces and potential bypass routes.

2. Equipment design capacities, expected flow and radionuclide concentrations, expected decontamination factors for radionuclides, and available holdup time. The system design capacity relative to the design and expected input flows, and the period of time the system is required to be in service to process normal waste flows. The availability of standby equipment, alternate processing routes, and interconnections between subsystems. This information is used in the ETSB review to evaluate the overall system capability to meet anticipated demands imposed by major processing equipment downtime and waste volume surges due to anticipated operational occurrences.

3. The quality group classifications of piping, and equipment, and the bases governing the design criteria chosen. Provisions to prevent, control and collect releases of radioactive material in liquids due to tank overflows from all plant systems, outside reactor containment having the potential to incur such releases. Design and expected temperatures and pressures, and materials of construction of the components of the liquid waste management system.

4. Design provisions incorporated in the equipment and facility design to reduce leakage and facilitate operation and maintenance in accordance with the guidelines of Regulatory Guide 1.143. (Ref. 10)

5. Special design features that would reduce liquid input volumes or discharge of radioactive material in liquid effluents. Special design features, topical reports incorporated by reference, and data obtained from previous experience with similar systems which are submitted with the SAR.

6. The technical specifications proposed by the applicant for process and effluent control will be reviewed at the operating license stage (FSAR).

Design provisions incorporated to sample and monitor radioactive materials in liquid process and effluent streams are reviewed under SRP Sections 11.5 and 9.3.2.

RAB will provide calculated doses based on the ETSB liquid source terms for inclusion in the staff's Environmental Impact Statement and Safety Evaluation Report.

SEB evaluates the applicant's proposed seismic design of structures housing the liquid radwaste system for inclusion in the staff's Safety Evaluation Report.

The consequences of liquid tank failures having the potential to release radioactive liquids are evaluated in SRP Section 15.7.3.

II. ACCEPTANCE CRITERIA

The applicant's design should meet the following criteria:

1. The liquid radwaste treatment system should have the capability to meet the requirements specified in 10 CFR Parts 20 and 50 and the dose design objectives specified in Appendix I to 10 CFR Part 50, including provisions to treat liquid radioactive waste such that:

   a. The calculated annual total quantity of all radioactive material released from each reactor at the site to unrestricted areas will not result in an estimated annual dose or dose commitment from liquid effluents for any individual in an unrestricted area from all pathways of exposure in excess of 3 millirems to the total body or 10 millirems to any organ.

   b. In addition to a. above, the liquid radwaste treatment systems should include all items of reasonably demonstrated technology that when added to the system sequentially and in order of diminishing cost-benefit return, can for a favorable cost-benefit ratio effect reductions in dose to the population reasonably expected to be within 50 miles of the reactor.

c. The concentrations of radioactive materials in liquid effluents released to an unrestricted area should not exceed the limits in 10 CFR Part 20, Appendix B, Table II, Column 2.

2. The liquid radwaste treatment system should be designed to meet the anticipated processing requirements of the station. Adequate capacity should be provided to process liquid wastes during periods when major processing equipment may be down for maintenance (single failures) and during periods of excessive waste generation. ETSB will accept systems that have adequate capacity to process the anticipated wastes and that are capable of operating within the design objectives during normal operation, including anticipated operational occurrences. To meet these processing demands, ETSB will consider interconnections between subsystems, redundant equipment, and reserve storage capacity.

3. The seismic design of structures housing liquid radwaste systems, the quality group classification of liquid radwaste treatment equipment, and provisions to prevent and collect spills from indoor and outdoor storage tanks should conform to the guidelines of Regulatory Guide 1.143.

4. ETSB will accept system designs that contain provisions to control leakage and facilitate operation and maintenance in accordance with the guidelines of Regulatory Guide 1.143.

III. REVIEW PROCEDURES

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

1. In the ETSB review of the liquid waste treatment system, the P&IDs and system process flow diagrams are reviewed to determine all sources of liquid input volumes, the points of collection of liquid waste, the flow paths of liquids through the system including all bypasses, the treatment provided, and the points of release of liquid effluents to the environment. This information is used to calculate the quantity of radioactive materials released annually in liquid effluents during normal operation, including anticipated operational occurrences, using the parameters given, the GALE Code, and calculational techniques given in NUREG-0016 and NUREG-0017. A complete Fortran listing of the GALE computer code is given in these reports. The results of this calculation will be used to determine whether the proposed treatment system design meets the acceptance criterion of II.1.c. Compliance with the acceptance criteria given in subsection II.1.a concerning exposures to the total body or critical organ of an individual in an unrestricted area will be determined based on RAB dose calculations using the ETSB-calculated source term.

Compliance with the acceptance criterion given in II.1.b concerning the cost-benefit analysis will be determined based on RAB man-rem dose calculations in conjunction with ETSB cost-benefit studies.

2. The ETSB review of the liquid waste treatment system design capacity will encompass three major areas:

   a. The system capability to process wastes in the event of a single major equipment item failure, e.g., an evaporator outage.

   b. The system capability to accept additional wastes during operations which result in excessive liquid waste generation.

   c. The system capability to process wastes at design basis fission product leakage levels, i.e., from 1% of the fuel producing power in a PWR or, in a BWR, consistent with a noble gas release of 100 μCi/sec/MWt measured after 30 minutes delay.

   ETSB will compare the average input flows to the design flows to determine the fraction of time individual subsystems must be online to process normal waste inputs. ETSB will review the operational flexibility designed into the system, i.e., cross connections between subsystems, redundant or reserve processing equipment, and reserve storage capacity. Based on the usage factors and operational flexibilities, ETSB will evaluate the overall system capability to process wastes in the event of (a), (b), or (c), above, by comparing the design flows to the potential process routes and equipment capacities ETSB will assume evaporators are unavailable for 2 consecutive days per week for maintenance. If two days holdup capacity or an alternative evaporator are not available for the process stream, ETSB will assume the stream is processed by an alternate route or discharged to the environment, consistent with the guidelines of NUREG-0016 and NUREG-0017.

3. ETSB compares the quality group classification for radwaste systems with the guidelines of Regulatory Guide 1.143. ETSB assures that the design includes provisions to prevent and collect leakage due to overflows and spillage from indoor and outdoor storage tanks, are in conformance with the guidelines of Regulatory Guide 1.143. SEB reviews the seismic design criteria of structures housing the liquid radwaste system in accordance with the design guidance identified in Regulatory Guide 1.143.

4. ETSB compares the system design, system and building layout, equipment design, method of operation, and provisions to reduce leakage and facilitate operations and maintenance with the guidelines of Regulatory Guide 1.143. ETSB will evaluate special design features provided to control leakage from system components and topical reports on systems designed on a case-by-case basis.

5. ETSB reviews the technical specifications proposed by the applicant for process and effluent control. The reviewer will determine that the content and intent of the technical specifications are in agreement with the requirements developed as a result of the staff's review. The review will include the evaluation or

development of appropriate limiting conditions for operation and their bases consistent with the plant design.

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 liquid radwaste treatment systems include the equipment and instrumentation to control the release of radioactive materials in liquid effluents."

In our evaluation, we have considered releases of radioactive materials in liquid effluents for normal operation including anticipated operational occurrences based on expected radwaste inputs over the life of the plant for each reactor on the _____ site. We have determined that the proposed liquid radwaste treatment systems are capable of maintaining releases of radioactive materials in liquid effluents such that the calculated individual doses in an unrestricted area from all pathways of exposure are less than 3 millirems to the total body and 10 millirems to any organ.

We have also considered the potential effectiveness of augmenting the proposed liquid radwaste treatment systems using items of reasonably demonstrated technology and have determined that further effluent treatment will not effect reductions in the cumulative population dose reasonably expected within a 50-mile radius of the reactor at a cost of less than $1000 per man rem or man-thyroid-rem.

We have also considered the potential consequences resulting from reactor operation, and we have determined the concentrations of radioactive materials in liquid effluents in unrestricted areas will be a small fraction of the limits in 10 CFR Part 20, Appendix B, Table II, Column 2.

We have considered the capabilities of the proposed liquid radwaste treatment system to meet the anticipated demands of the plant due to anticipated operational occurrences and have concluded that the system capacity and design flexibility are adequate to meet the anticipated needs of the plant.

We have reviewed the applicant's quality assurance provisions for the liquid radwaste systems, the quality group classifications used for system components, and the seismic design applied to structures housing these systems. The design of the systems and structures housing these systems meet the criteria as set forth in Regulatory Guide 1.143.

We have reviewed the provisions incorporated in the applicant's design to control the release of radioactive materials in liquids due to inadvertent tank overflows and conclude that the measures proposed by the applicant are consistent with the criteria as set forth in Regulatory Guide 1.143. 149 140

Based on the foregoing evaluation, we conclude that the proposed liquid radwaste treatment system is acceptable. The basis for acceptance has been conformance of the applicant's design, design criteria, and design bases for the liquid radioactive waste treatment systems to the Commission's regulations and to applicable Regulatory Guides, as referenced above.

V. REFERENCES

1. 10 CFR Part 20, "Standards for Protection Against Radiation," and Appendix B, "Concentration in Air and Water Above Natural Background."

2. 10 CFR § 50.34a, "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents - Nuclear Power Reactors."

3. 10 CFR § 50.36a, "Technical Specifications on Effluents from Nuclear Power Reactors."

4. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants."

5. 10 CFR Part 51, "Licensing and Regulatory Policy and Procedures for Environmental Protection."

6. 10 CFR Part 50, Appendix I, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low As Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents.

7. Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants."

8. NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWRs)."

9. NUREG-0016, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors (BWRs)."

10. Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures and Components in Light-Water-Cooled Nuclear Reactor Power Plants."