



U.S. NUCLEAR REGULATORY COMMISSION  
**STANDARD REVIEW PLAN**  
OFFICE OF NUCLEAR REACTOR REGULATION

11.2 LIQUID WASTE MANAGEMENT SYSTEMS

REVIEW RESPONSIBILITIES

Primary - Effluent Treatment Systems Branch (ETSB)

Secondary - Radiological Assessment Branch (RAB)

I. AREAS OF REVIEW

The primary review function is performed by ETSB. 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, 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. The ETSB review includes:

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 including 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.
3. 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.
4. The availability of standby equipment, alternate processing routes, and interconnections between subsystems in order 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.
5. The quality group classifications of piping, and equipment, and the bases governing the design criteria chosen.

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USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

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6. 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.
7. Design and expected temperatures and pressures, and materials of construction of the components of the liquid waste management system.
8. 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. 8)
9. Design features that would reduce liquid input volumes or discharge of radioactive material in liquid effluents.
10. Special design features that may be unique to the plant, topical reports incorporated by reference, and data obtained from previous experience with similar systems which are submitted with the SAR.

ETSB reviews the design provisions of the liquid radwaste system incorporated to sample and monitor radioactive elements in liquid process and effluent streams as part of its primary responsibility for SRP Section 11.5.

ETSB also reviews the consequences of a liquid tank failure having the potential to release radioactive material to a portable water supply as part of its primary review responsibility for SRP Section 15.7.3.

A secondary review is performed by the RAB and the results are used by ETSB to complete the overall evaluation of the system. RAB performs the dose calculations based on the liquid source term provided by ETSB and transmits the results to ETSB for their use in evaluating the gaseous waste processing system. RAB also reviews the dose calculational portions of the radiological effluent technical specifications for input into SRP Section 16.0.

In addition, ETSB will coordinate other branches' evaluations that interface with the overall review of the system as follows: the Structural Engineering Branch (SEB) determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category 1 structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), probable maximum flood (PMF), and tornado missiles as part of its primary review responsibility for SRP Sections 3.3.1, 3.3.2, 3.5.3, 3.7.1 through 3.7.4, 3.8.4, and 3.8.5. The Mechanical Engineering Branch (MEB) determines the acceptability of the seismic and quality group classifications for system components as part of its primary review responsibility for SRP Sections 3.2.1 and 3.2.2. The Accident Evaluation Branch (AEB) evaluates the radiological consequences of the release to the atmosphere of radioactive fission gases resulting from an unexpected and uncontrolled release of radioactive liquids as part of its primary review responsibility for SRP Section 15.7.2. The reviews for technical specifications and quality assurance are coordinated and performed by the Licensing Guidance Branch and the Quality Assurance Branch (QAB) 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

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

1. 10 CFR Part 20, § 20.106 as it relates to radioactivity in effluents to unrestricted areas.
2. 10 CFR Part 50, § 50.34a as it relates to sufficient design information being provided to demonstrate that design objectives for equipment necessary to control releases of radioactive effluents to the environment have been met.
3. General Design Criterion 60 as it relates to the radioactive waste management systems being designed to control releases of radioactive materials to the environment.
4. General Design Criterion 61 as it relates to radioactive waste systems to be designed to assure adequate safety under normal and postulated accident conditions.

The relevant requirements of the Commission regulations identified above are met by using the regulatory positions contained in the following regulatory guides listed below.

- a. Regulatory Guide 1.110 as it relates to performing a cost-benefit analysis for reducing cumulative dose to the population by using available technology.
  - b. Regulatory Guide 1.143 as it relates to the seismic design and quality group classification of components used in the liquid waste treatment system and structures housing systems and the provisions used to control leakages.
5. 10 CFR Part 50, Appendix I, Sections II.A and II.D as it relates to the numerical guides for dose design objectives and limiting conditions for operation to meet the "as low as is reasonably achievable" criterion.

The liquid radwaste treatment system should have the capability to meet the requirements specified in 10 CFR Part 20, § 20.106 and 10 CFR Part 50, § 50.34a, and General Design Criteria 60 and 61 of Appendix A of 10 CFR Part 50 and the dose design objectives specified in Sections II.A and II.D of Appendix I to 10 CFR Part 50, including provisions to treat liquid radioactive waste.

1. Specific criteria necessary to meet the relevant requirements of the Commission regulations are as follows:
  - 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 1.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. Regulatory Guide 1.110 provides an acceptable method for performing this analysis.
  - 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

ETSB reviews the applicants submittal in the following manner:

1. 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. The results of this calculation will be used to determine whether the proposed treatment system design meets the acceptance criterion of subsection II.1.c and in review of SRP Section 11.1. 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 subsection 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  $\mu\text{Ci/sec/MWt}$  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 seismic and quality group classification for radwaste systems with the guidelines of Regulatory Guide 1.143. Exceptions are transmitted to MEB in accordance with our coordinated review responsibility given in subsection I, above. ETSB assures that the design includes provisions to prevent and collect leakage due to overflows and spillage from indoor and outdoor storage tanks, and are in conformance with the guidelines of Regulatory Guide 1.143. ETSB reviews the seismic design criteria of structures housing the liquid radwaste system in accordance with the design guidance identified in Regulatory Guide 1.143. Exceptions are transmitted to SEB in accordance with our coordinated review responsibility given in subsection I, above.
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 for input into SRP Section 16.0. RAB reviews the dose calculation portions of the technical specifications for input into SRP Section 16.0. 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. The technical specifications are reviewed with respect to the requirements of 10 CFR Part 50, § 50.34a.

#### 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 systems includes the equipment necessary to control the releases of radioactive materials in liquid effluents in accordance with General Design Criteria 60 and 61 of Appendix A of 10 CFR Part 50 and 10 CFR Part 50, § 50.34a. The staff concludes that the design of the liquid waste management systems is acceptable and meets the requirements of 10 CFR Part 20, § 20.106, 10 CFR Part 50, § 50.34a, General Design Criteria 60 and 61 and 10 CFR Part 50, Appendix I. This conclusion is based on the following:

1. The applicant has met the requirements of Section II.A of Appendix I of 10 CFR Part 50 with respect to dose limiting objectives by proposing a liquid radwaste treatment systems that is 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. In the staff's 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 in accordance with SRP Section 11.1.
2. The applicant has met the requirements of Section II.D of Appendix I of 10 CFR Part 50 with respect to meeting the "as low as reasonably achievable" criterion since we have 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.
3. The applicant has met the requirements of 10 CFR Part 20, §20.106 since we have 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.
4. The applicant has met the requirements of General Design Criterion 60 and 61 with respect to controlling releases of radioactive material to the environment since we have considered the capabilities of the proposed liquid radwaste treatment system to meet the 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.

5. The applicant has met the requirements of 10 CFR Part 50, § 50.36a with respect to providing technical specifications pertaining to the liquid radwaste systems so that the provisions of the specifications are sufficient to insure that they fulfill the requirement of the regulation.

## 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 reference regulatory guides.

## VI. 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 Part 50, § 50.34a, "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents - Nuclear Power Reactors."
3. 10 CFR Part 50, § 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 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."
6. NUREG-0016, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors (BWRs)."
7. NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWRs)."
8. Regulatory Guide 1.110, "Cost Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors."

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