



U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN

BRANCH TECHNICAL POSITION 11-6**POSTULATED RADIOACTIVE RELEASES DUE TO LIQUID-CONTAINING TANK FAILURES****REVIEW RESPONSIBILITIES**

Primary - Organization responsible for review of effectiveness of radwaste systems.

Secondary - None

A. Background

During normal operation, nuclear power plants generate radioactive materials, as fission and activation products, which are present in primary coolant and steam, and secondary coolant and steam. Primary and secondary coolants are processed by the liquid waste management system (LWMS). The LWMS is designed to ensure that liquids and liquid wastes produced during normal operation, including anticipated operational occurrences, are handled, processed, recycled as coolant, or released in accordance with relevant NRC regulations. The LWMS is comprised of permanently installed plant systems and mobile processing equipment. Typically, such systems include tanks, piping, pumps, valves, filters, demineralizers, and additional equipment that are necessary to process and treat liquid wastes. The design of the LWMS is governed by GDC 60 and 61 and 10 CFR 50.34a. The requirements for operational procedures and technical specifications are mandated under 10 CFR 50.36a. SRP Section 11.2 describes the design acceptance criteria for the LWMS. The classification of LWMS equipment and piping and bases governing design criteria should be developed in accordance with the guidelines of Regulatory Guide 1.143, as described in SRP acceptance

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USNRC STANDARD REVIEW PLAN

This Standard Review Plan, NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The standard review plan sections are numbered in accordance with corresponding sections in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of Regulatory Guide 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRR_SRP@nrc.gov.

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criteria. In addition, the design should incorporate features to reduce leakage and spills, and facilitate operation and maintenance in accordance with the guidance of Regulatory Guide 1.143 and requirements of 10 CFR Part 20.1406.

LWMS design features and characteristics differ among plants, but the most important common characteristic among plants is that designs incorporate the guidance of Regulatory Guide 1.143. As a result, a gross failure of the LWMS is considered highly unlikely, e.g., such as a failure involving the near total loss of the system's inventory of radioactive materials. However, the malfunction of a tank and its components, a valve misalignment, tank overflow, or an operator error appear more likely and are assumed to be types of failures warranting an evaluation of their consequences. Although no specific types of system failures have been designated as being representative, it was considered that for the safety evaluation of the LWMS, the type of malfunction analyzed should be limited to the postulated failure of a tank or pipe rupture, located outside of containment. The evaluation considers the impact of the failure on the nearest potable water supply, and the use of water for direct human consumption or indirectly through animals (livestock watering), crops (agricultural irrigation), and food processing (water as an ingredient).

The purpose of this BTP is to provide guidelines in defining the mechanism of the failure, assumptions used for the analysis, and approach applied in assessing the radiological impact. The objective is to develop an estimate of the amounts of radioactive materials released in an unrestricted area, and provide reasonable assurance that the radiological consequences of the failure of an active component in the LWMS will not result in radionuclide concentrations in excess of the limits of Appendix B (Table 2, Column 2, under the unity rule) to 10 CFR Part 20 in the nearest source of potable water, located in an unrestricted area, and use of that water for direct and indirect human consumption, as described above.

Section B, below, provides an acceptable approach in addressing the concerns outlined above. This position paper sets forth minimum requirements and does not prohibit the implementation of more rigorous design codes, standards, or quality assurance measures than those indicated in this BTP. Also, it does not require a re-evaluation of LWMS with limiting conditions or controls for operation based on more conservative analysis and calculational assumptions.

B. BRANCH TECHNICAL POSITION

The NRC staff will review the information describing the design features of the LWMS provided in the SAR, the DC application, update of the FSAR, or the COL application, to the extent not addressed in a referenced certified design, including the relevant parts of SRP Sections 2.4.1, 2.4.12, and 2.4.13 in accordance with Regulatory Guide 1.70 or 1.206. The reviewer will select and emphasize material from the procedures described below, as may be appropriate for a particular case.

1. Site Geology and Hydrology and Conceptual Transport Models

The staff will review the site's geologic and hydrologic features in assessing the potential consequences of a release radioactive materials associated with the failure of a tank and its components on current and likely future users of ground or surface water. The review of information on surface and ground water hydrology, parameters governing the movement of liquids and mobility of radioactivity through soils, and potential dilution in water is performed under SRP Section 2.4.13. Briefly, these sections of the SRP address information describing

streams and lakes, regional and local ground water aquifers, sources, and sinks, local and regional ground water users, known and likely future withdrawal rates, regional flow rates, travel time, gradients, and velocities, subsurface properties that affect movement of contaminants in ground water, ground water levels including their seasonal and climatic fluctuations, ground water monitoring and protection requirements, man-made changes that may affect regional ground water characteristics over time, and local practices in using water resources.

2. Radioactive Source Term

The proposed radionuclide concentrations assumed for the postulated failure of a tank and its components will be reviewed by the staff using the information presented by the applicant. The analysis assumes that a tank and its components fail to meet the design bases as required by 10 CFR Part 50.34a, and General Design Criteria 60 and 61. The staff will evaluate the basis and assumptions used in developing the source terms, radionuclide distributions and concentrations to ensure that the highest potential radioactive material inventory is selected among the expected types of liquid and wet waste streams processed by the LWMS. The radionuclide inventory for the tank and its components assumed to fail is based on 80% of the volume capacity of that tank and its component.

The radionuclides selected for the radioactive source term and total inventory should include those that have the highest potential exposure consequences to users of water resources, including long-lived fission and activation products and environmentally mobile radionuclides. The radionuclide concentrations and total inventory of radioactive materials is based on the expected failed fuel fraction, i.e., 0.12% of the fuel producing power in a pressurized water reactor (PWR) as per NUREG-0017, or consistent with an offgas release rate of 0.555 MBq/sec per MWt (15 μ Ci/sec per MWt) after a 30-minute delay for a boiling water reactor (BWR) as per NUREG-0016. The radionuclide inventory in failed components is calculated based on the methods given in Chapter 4 and Appendices A and B of NUREG-0133, or by using equivalently documented techniques.

The staff will confirm that the initial inventory of radioactive materials corresponds to the highest expected concentrations and inventory of radioactivity in systems and components used to process, treat, or store liquid and wet wastes products associated with normal operation and anticipated operational occurrences. The reviewer will determine whether the tank and its components, for which a failure is assumed, will result in the highest concentrations of radioactive materials at the nearest potable water supply located in an unrestricted area.

3. Mitigating Design Features

The staff will determine whether the analysis has considered the use of design features, e.g., steel liners or walls in areas housing components, dikes for outdoor tanks, and overflow provisions incorporated to mitigate the effect of a postulated tank failure. The types of failed components are typically waste collector tanks or sample tank, among others. However, the components selected for the analysis should realistically reflect the specific design features of the plant, as described in Sections 11.2 and 11.4 of the application. The staff will coordinate this part of the evaluation with the organization responsible for the review of systems and components that are part of the balance of plant. The purpose of this review is to ensure that the analysis considered the proper selection of the failed equipment, and appropriate release mechanisms from the selected equipment and buildings housing such systems.

Credit for liquid retention by unlined building foundations will not be given regardless of the building seismic category because of the potential for cracks. Credit is not allowed for retention by coatings or leakage barriers outside the building foundation.

4. Specifications on Tank Waste Radioactivity Concentration Levels

The reviewer will evaluate the proposed technical specification limiting the radioactivity content (becquerel, curie) of liquid-containing tanks to ensure that the technical specification is consistent with the safety evaluation. Chapter 16 of the SRP identifies the requirements for this technical specification. The radioactivity content (becquerel, curie) is based on that quantity which would not exceed the concentration limits of 10 CFR Part 20, Appendix B, Table 2, Column 2, at the nearest potable water supply, located in an unrestricted area, in the event of an uncontrolled release of the tank's contents.

C. TECHNICAL RATIONALE

The technical rationale for these acceptance criteria applied in reviewing the postulated radioactive releases due to liquid-containing tank failures is as follows:

1. Compliance with General Design Criteria 60 and 61 require, in part, that the nuclear power plant design shall include means to control the release of radioactive materials in gaseous and liquid effluents, and provide adequate safety during normal reactor operation, including anticipated operational occurrences.

GDC 60 and 61 are applicable to this BTP because this section is concerned with tanks and associated components outside of containment that could contain radioactive liquids. A single failure of these tanks could release radioactive liquids to surface or ground water and potentially endanger the public.

Meeting this criterion provides assurance that releases of radioactive materials due to a single failure of liquid-containing tanks outside of containment during normal operations or anticipated operational occurrences will not result in potable water concentrations exceeding the limits specified in 10 CFR Part 20.

2. Compliance with 10 CFR Part 20 (Appendix B) requires that radioactive materials released in liquid effluents do not result in radionuclide concentrations in excess of those values listed in Table 2, Column 2 at a potable water supply located in an unrestricted area.

Appendix B to 10 CFR Part 20 is applicable to this BTP because it is concerned with tanks and associated components outside of containment that could contain radioactive liquids. A single failure of these tanks could release radioactive liquids to surface and ground water and potentially endanger the public. GDC 60 requires that the nuclear power unit design include the means to control the release of radioactive materials in gaseous and liquid effluents and 10 CFR Part 20 (Appendix B) provides effluent concentration limits in the unlikely event of a single failure of liquid-containing tanks outside of containment.

Meeting this criterion provides assurance that releases of radioactive materials due to a postulated single failure of liquid-containing tanks outside of containment during normal

operations or anticipated operational occurrences will not result in releases that exceed the limits specified in 10 CFR Part 20, Appendix B, Table 2 effluent concentration limits using the unity rule and sum-of-the-fractions.

D. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations support conclusions of the following types to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The scope of the review included the calculation of radionuclide concentrations in the applicable failed components based upon the expected PWR fuel failure rate or BWR fuel release rate for the plant, and the effect of site hydrology for those systems that have not been provided with special design features to mitigate the effects of failures. Radionuclide concentrations at the nearest potable water supply were found to be acceptable. The basis for acceptance has been that the staff's review shows that the postulated failure of a tank and its associated components would not result in radionuclide concentrations in excess of 10 CFR Part 20, Appendix B, Table 2, Column 2, at the nearest source of potable water as described in the application.

For those cases where special design features were incorporated to mitigate the consequences of a failure of a tank and its associated components, the following type of statement is made:

Tanks for which special design features were incorporated to mitigate the consequences of failures, such as steel liners or walls or dikes surrounding the failed tanks and their components and tank overflow provisions, were evaluated and found to be acceptable. The basis for the staff's acceptance was the capability of these design provisions to prevent the release of radioactivity from entering a potable water supply system. Therefore, the staff concludes that the design provisions incorporated by the applicant are acceptable in mitigating the effects of the failure of a tank and its associated components involving radioactive liquids.

For either case, the staff concludes that the postulated failure of a tank and its associated components has been evaluated and the design is acceptable and meets the requirements of General Design Criteria 60 and 61 for the control of releases of radioactive materials to the environment and provides an adequate level of safety during normal reactor operation, including anticipated operational occurrences. This conclusion is based on the following:

The applicant has met the requirements of General Design Criteria 60 and 61 with respect to the control of releases of radioactive materials to the environment by providing controls to reduce the potential impact of the failure of a radioactive liquid-containing tank and its associated components. Such a release will not result in concentrations of radioactive materials exceeding the limits of 10 CFR Part 20, Appendix B, Table 2, Column 2 in the nearest source potable water located in an unrestricted area, as described in the application.

For DC and COL reviews, the findings will also summarize (to the extent that the review is not discussed in other SER sections) the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable, and interface requirements and COL action items relevant to this SRP section.

E. REFERENCES

1. 10 CFR 20.1406, "Minimization of Contamination."
2. 10 CFR Part 20, Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage."
3. 10 CFR 50.34a, "Design objectives for equipment to control releases of radioactive material in effluents nuclear power reactors."
4. 10 CFR 50.36a, "Technical specifications on effluents from nuclear power reactors."
5. 10 CFR Part 50, Appendix A, GDC 60, "Control of releases of radioactive materials to the environment."
6. 10 CFR Part 50, Appendix A, GDC 61, "Fuel storage and handling and radioactivity control."
7. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."
8. Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I."
9. Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."
10. Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures and Components Installed in Light-Water-Cooled Nuclear Reactor Power Plants."
11. NUREG-0016, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors (BWRs) (BWR-GALE Code)."
12. NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWRs) (PWR-GALE Code)."
13. NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants."

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

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