



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

SECTION 11.1 SOURCE TERMS

REVIEW RESPONSIBILITIES

Primary - Effluent Treatment Systems Branch (ETSB)

Secondary - None

I. AREAS OF REVIEW

At the construction permit (CP) stage of review, ETSB reviews the information in the applicant's safety analysis report (SAR) on the sources of radioactivity that are input to the radioactive waste management systems for treatment of liquid and gaseous wastes. At the operating license (OL) stage of review, ETSB review consists of confirming the information accepted at the CP stage.

1. ETSB review of radioactive source terms includes consideration of parameters used to determine the concentration of each isotope in the reactor coolant; fraction of fission product activity released to the reactor coolant; concentrations of all nonfission product radioactive isotopes in the reactor coolant; leakage rates and associated fluid activity for all potentially radioactive water and steam systems; and potential sources of radioactive materials in effluents that are not considered in the applicant's safety analysis report (SAR) Section 11.2, "Liquid Waste Management Systems," and SAR Section 11.3, "Gaseous Waste Management Systems." The following sources are considered in the evaluation of effluent releases:
  - a. Boiling water reactor (BWR) gaseous wastes (noble gases, radioiodine, and particulates, carbon-14 and tritium), consisting of offgases from the main condenser evacuation and turbine gland sealing systems, steam and liquid leakage to containment, radwaste, turbine, fuel handling and auxiliary buildings, and ventilation system exhausts from buildings having the potential for containing radioactive materials.
  - b. BWR liquid wastes, consisting of leakage to equipment and floor drains from buildings housing equipment and components that may contain radioactive fluids; contaminated liquids produced by plant operations, such

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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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as demineralizer regenerants and resin sluice water, filter backwashes, ultrasonic resin cleaning rinses, decontamination solutions, and laboratory samples and rinses; and detergent wastes.

- c. Pressurized water reactor (PWR) gaseous wastes (noble gases, radioiodine, and particulates, carbon-14 and tritium), consisting of offgases from the steam generator blowdown flash tank; offgases from the main condenser evacuation system; leakage to containment, fuel handling, auxiliary, and turbine buildings; noble gases stripped from the primary coolant during normal operation and at shutdown; and cover and vent gases from tanks and equipment containing radioactive material.
  - d. PWR liquid wastes, consisting of primary coolant processed to control boron concentration (shim bleed); leakage collected in equipment and floor drains from buildings housing equipment and components that may contain radioactive fluids; steam generator blowdown; condensate demineralizer regenerant solutions; contaminated liquids from anticipated plant operations such as resin sluices, filter backwashes, decontamination solutions, and sample station drains; and detergent wastes.
2. The releases of radioactive materials in liquid and gaseous effluents calculated by ETSB will be used in SRP Sections 11.2 and 11.3 to evaluate the liquid and gaseous waste systems.

## II. ACCEPTANCE CRITERIA

ETSB will accept the source terms used as the design basis for expected releases if the following Commission regulations are met:

1. 10 CFR Part 20 as it relates to radioactivity in effluents to unrestricted areas.
2. 10 CFR Part 50, Appendix I as it relates to the numerical guides for design objectives and limiting conditions for operation to meet the criterion "as low as is reasonably achievable" given in the Appendix I.
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.

The requirement of the Commission regulations identified above are met by using the regulatory positions contained in the following regulatory guides:

- a. Regulatory Guide 1.110 as it relates to the cost-benefit analysis for radioactive waste management systems and equipment.
- b. Regulatory Guide 1.112 as it relates to the method of calculating release of radioactive materials in effluents from nuclear power plants.
- c. Regulatory Guide 1.140 as it relates to the design testing and maintenance of normal ventilation exhaust systems at nuclear power plants.

Specific criteria necessary to meet the relevant requirements of 10 CFR Part 20 and 10 CFR Part 50 are as follows:

1. The parameters used to calculate primary and secondary coolant concentrations for PWRs are consistent with those given in NUREG-0017 (Ref. 1). The parameters used to calculate coolant concentrations for BWRs are consistent with those given in NUREG-0016 (Ref. 2).
2. All normal and potential sources of radioactive effluent delineated in subsection I are considered.
3. For each source of liquid and gaseous waste considered in subsection I.1, the volumes and concentrations of radioactive material given for normal operation and anticipated operational occurrences are consistent with those given in NUREG-0016 or NUREG-0017.
4. Decontamination factors for inplant control measures used to reduce gaseous effluent releases to the environment, such as iodine removal systems and high efficiency particulate air (HEPA) filters for building ventilation exhaust systems and containment internal cleanup systems are consistent with those given in Regulatory Guide 1.140 (Ref. 3). The building mixing efficiency for containment internal cleanup is consistent with NUREG-0017.
5. Decontamination factors for inplant control measures used to reduce liquid effluent releases to the environment, such as filters, demineralizers and evaporators, are consistent with those given in NUREG-0016 or NUREG-0017.
6. Radwaste augments used in the calculation of effluent releases to the environment are consistent with the findings of a cost-benefit analysis, performed using the guidance of Regulatory Guide 1.110 (Ref. 4). The provisions that require a cost-benefit analysis are stated in Section II.D of Appendix I to 10 CFR Part 50 (Ref. 5).
7. The source terms meet the "as low as is reasonably achievable" objective for effluent releases as required by paragraph c of Section 20.1 of 10 CFR Part 20 (Ref. 6).
8. The source terms result in meeting the design objectives for doses in an unrestricted area as set forth in Appendix I to 10 CFR Part 50.
9. For evaluating the source terms, the applicant should provide the relevant information in the SAR as required by 10 CFR Part 50, Section 50.34 (Ref. 7) and 10 CFR Part 50, Section 50.34a (Ref. 8). This technical information should include all the basic data listed in Appendix A (BWRs) and Appendix B (PWRs) to Regulatory Guide 1.112 (Ref. 9) required in calculating the releases of radioactive material in liquid and gaseous effluents (the source terms). An acceptable method for satisfying the criteria given in items 1 through 6 consists of using the gaseous and liquid effluent (GALE) Computer Code and the source term parameters given in NUREG-0016 or NUREG-0017 for BWRs and PWRs respectively. Complete listings of the GALE Computer Codes for BWRs and PWRs are given in NUREG-0016 and NUREG-0017 respectively.

10. If the applicant's calculational technique or any source term parameter differs from that given in NUREG-0016 and NUREG-0017, they should be described in detail and the bases for the methods and parameters used should be provided.

### III. REVIEW PROCEDURES

The reviewer will select and emphasize material from this SRP section as may be appropriate for a particular case.

1. In the review of the mathematical models and parameters given in the SAR to calculate primary coolant concentrations, and of the leakage rates to the radioactive waste management systems, ETSB compares parameters and calculations given in the SAR with the models and parameters given in NUREG-0016 and NUREG-0017. If the SAR includes models or parameters to estimate reactor coolant concentrations and leakage rates that differ from these reports, the parameters and calculations used need to be substantiated. The preferred method of substantiation is by presentation of operating data from similar reactors.
2. ETSB performs an independent calculation of the primary and secondary (PWR) coolant concentrations and of the release rates of radioactive materials using the GALE Computer Code, and the "Principal Parameters for Source Term Calculations" given in NUREG-0016 and NUREG-0017, and the information supplied by the applicant in accordance with Appendices A and B of Regulatory Guide 1.112.
3. In the calculation, ETSB will use the applicant's values as given in the SAR for the following parameters: design core thermal power level, steam flow rate, coolant mass, and coolant purification rates.
4. ETSB will use the coolant concentrations, leakage rates, and effluent release rates calculated above as inputs for evaluation of the liquid waste system, under SRP Section 11.2, and the gaseous waste systems, under SRP Section 11.3, to determine if these systems meet the dose design objectives of Appendix I to 10 CFR Part 50.
5. The ETSB will review under SRP Section 11.5 "Process and Effluent Radiological Monitoring and Sampling Systems," the monitoring and control provisions for all the applicable effluent release points identified in subsection I.1, above.
6. The ETSB source term calculations are used for both the review of the SAR and for the staff's Environmental Impact Statement.

### IV. EVALUATION FINDINGS

Sufficient information has been provided by the applicant so that the requirements of 10 CFR Part 50, Sections 50.34 and 50.34a have been met. The ETSB summary statement on the acceptability of source terms used as design parameters for the waste management systems will be made under SRP Sections 11.2, "Liquid Waste Systems," and 11.3, "Gaseous Waste Systems."

## 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 and NUREGs.

## VI. REFERENCES

1. NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWRs)."
2. NUREG-0016, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors (BWRs)."
3. Regulatory Guide 1.140, "Design, Testing, and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."
4. Regulatory Guide 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors."
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," May 5, 1975.
6. 10 CFR Part 20, "Standards for Protection Against Radiation."
7. 10 CFR Part 50, Section 50.34, "Domestic Licensing of Production and Utilization Facilities - Contents of applications; technical information."
8. 10 CFR Part 50, Section 50.34a, "Domestic Licensing of Production and Utilization Facilities - Design objectives for equipment to control releases of radioactive material in effluents - nuclear power reactors."
9. Regulatory Guide 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluent from Light-Water-Cooled Power Reactors."
10. 10 CFR Part 50, Appendix A, General Design Criterion 60, "Control of Releases of Radioactive Materials to the Environment."
11. 10 CFR Part 50, Appendix A, General Design Criterion 64, "Monitoring Radioactivity Releases."