



# U.S. NUCLEAR REGULATORY COMMISSION

## STANDARD REVIEW PLAN

### 11.1 COOLANT SOURCE TERMS

#### REVIEW RESPONSIBILITIES

**Primary**— Organization responsible for the review of the coolant source ~~terms~~ terms associated with normal operations, anticipated operational occurrences, and accident conditions.

**Secondary**— None.

#### I. AREAS OF REVIEW

At the For reviews of early site ~~permit~~ permits (ESP), construction ~~permit~~ permits (CP) ~~or~~, standard design certification ~~stage of review, the~~ (DC), and combined licenses (COL) that do not reference a DC, the U.S. Nuclear Regulatory Commission (NRC) staff reviews the information in the applicant's ~~safety analysis report (SAR) on the~~ Safety Analysis Report (Preliminary Safety Analysis Report (PSAR) or Final Safety Analysis Report (FSAR)) as it relates to the sources of radioactivity that are ~~input to the~~ processed by radioactive waste management systems ~~for treatment of (RWMS) in treating~~ liquid and gaseous wastes. At the For operating ~~license~~ licenses (OL) or ~~combined license (COL) stage of review~~ COLs that reference a DC, the staff confirms that the information accepted at the CP or standard ~~design certification stage~~ DC stage is appropriately incorporated in the relevant sections of OL or COL applications, and that proposed departures are adequately justified and documented.  
The

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#### USNRC STANDARD REVIEW PLAN

This Standard Review Plan (SRP), NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission (NRC) 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 regulations. The SRP is not a substitute for the NRC 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 SRP sections are numbered in accordance with corresponding sections in Regulatory Guide (RG) 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of RG 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 RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)." These documents are made available to the public as part of the NRC 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 [NRO\\_SRP@nrc.gov](mailto:NRO_SRP@nrc.gov).

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The Standard Review Plan (SRP) utilizes various source terms for a variety of purposes, including:

1. Normal operational source term, based on operational reactor experience, as described in American National Standards Institute/American National Standard (ANSI/ANS) N18.1. Addressed in SRP Section 11.1 for reactor coolant (primary and secondary) and reactor steam design details, and in SRP Section 11.2, "Liquid Waste Management System," and SRP Section 11.3, "Gaseous Waste Management System," for system design features used to process and treat liquid and gaseous effluents before being released or recycled
2. Anticipated operational occurrences (AOOs) source term, based on the technical specifications (TS), or the design basis source term, whichever is more limiting, is used to determine the effects of events like primary to secondary leaks and reactor steam source terms. This is addressed in SRP Section 11.1 for reactor coolant (primary and secondary) and reactor steam design details.
3. Design basis source term, based on 0.25 - 1 percent fuel defects, is used to determine shielding and ventilation design requirements. Addressed in SRP Section 12.2, "Radiation Sources," source terms contained in systems and components. This information is also used in SRP Section 12.2 to develop post-accident shielding (for vital area access, including work areas) source terms in addressing NUREG-0737, "Clarification of TMI Action Plan Requirements," Item II.B.2, or Regulatory Guide (RG) 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors."
4. Equipment qualification (EQ) source term, which may or may not be more limiting than the stated accident source term. Addressed in SRP Section 3.11, "Environmental Qualification of Mechanical and Electrical Equipment" and SRP Section 12.2 in developing source terms used to assess dose and dose rates to equipment.
5. Accident source term, which is based on Design Basis Events (DBE), is used to determine dose to the public and plant operators during a DBE. Addressed in SRP Chapter 15, "Transient and Accident Analysis."

As described below, this SRP section addresses the derivation and the use of the source terms described in Items 1 and 2 above. Other SRP sections may utilize parameters (i.e., letdown rate, removal efficiencies, and decontamination factors, etc.) described within SRP Chapter 11 as the basis for deriving the design bases for shielding and ventilation utilizing the source term described in Item 3. As a result, the information needed for the staff to conduct its evaluation will require the review of several PSAR/FSAR sections to confirm the relevance and adequacy of the supporting information used by the applicant in developing source terms.

This SRP section addresses the review of coolant source terms used to evaluate RWMS in pressurized water reactors (PWRs) and boiling water reactors (BWRs). The review does not address an evaluation of plant and process equipment, given the purpose and scope of SRP Sections 11.2 to 11.5, but does rely on plant operating characteristics and RWMS design parameters in calculating radionuclide concentrations in primary and secondary coolant and reactor steam. Similarly, this SRP section does not include a review on the generation of

neutron-activated components, in-core neutron detectors, or spent-fuel. Two source terms are reviewed: radioactive materials expected during normal operations and AOOs, and design basis source terms. For the purpose of this SRP section, radionuclide concentrations in primary and secondary coolant and reactor steam are expected to be representative of operating experience and plant conditions over the life of the plant in estimating radioactivity levels in process and effluent streams. The resulting radionuclide concentrations are not intended to be used as the sole basis for the design of the plant and RWMS.

The design basis coolant source term is used to derive inventories of radioactivity in system components, assess the adequacy of shielding in maintaining doses to workers and the public as low as reasonably achievable (ALARA) define ambient radiation exposure levels and zones, and confirm the proper placement of radiation monitoring equipment in plant areas and operating conditions and the design of ventilation systems provided for maintaining doses to workers ALARA, consistent with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20, Subparts G and H. The design basis source term represents a conservative characterization of primary and secondary coolant concentrations. The source term is based on a combination of assumptions of failed fuel fractions (e.g., 0.25 to 1 percent,) TS limits for halogens (I-131 dose equivalent) and noble gases (Xe-133 dose equivalent,) presence of activation and corrosion products, and steam generator TS limits on primary-to-secondary leakage.

This information may be used, in part, to support the development of other source terms, such as source terms framing assumptions for design basis accidents, source terms used in evaluating radiation doses for equipment qualification, and source terms used as the basis for radiation protection measures for other materials stored in spent-fuel pools. For these specific applications, the requirements and guidance, and the staff's evaluation process are addressed in SRP Sections 3.11, 12.2, and 15.0.3, "Design Basis Accident Radiological Consequences of Analyses for Advanced Light Water Reactors." Guidance on how the results of the staff's evaluation and acceptability of these source terms and associated system parameters are applied in their development is provided in SRP Section 3.11 for equipment qualifications, SRP Section 12.2 for radiation protection purposes and shielding design, and SRP Section 15.0.3 for design basis accidents.

Reactor coolant and steam source terms for normal operation are based on operating experience of plants with similar types of fuels used in PWRs and BWRs. The normal operation source terms are used to assess the performance of RWMS and other systems under normal operating conditions (including AOOs). The design basis reactor coolant and steam source terms are used to assess equipment qualification and model releases under design basis accident conditions for evaluation against the reactor siting criteria and control room radiological habitability requirements. The main difference in the two source terms (normal operation versus design basis) is the adjustment made in deriving radionuclide concentrations in primary and secondary coolants and reactor steam. See SRP Section 3.11 on equipment qualification and SRP Chapters 12 and 15 for details on the development of the design basis source term.

The review will consider the following topics:

1. The staff's review of the radioactive coolant source terms includes consideration of parameters used to determine the concentration of ~~each isotope~~ radionuclides in the reactor coolant; fraction of fission product activity released to the reactor coolant; and concentrations of all ~~nonfission product radioactive isotopes in the reactor coolant~~ non-

fission products in reactor primary coolant and steam, and in secondary coolant and steam. Nevertheless, the generation of fission and activation products, fuel enrichment, fuel cladding and defects, presence of radioactivity in primary and secondary coolant and reactor steam, type coolant purification systems used in light-water reactors (LWR) generally have common features, and RWMS used to process liquid and gaseous wastes have essentially identical functions. The following sources of radioactivity and associated parameters are considered in the evaluation of effluent releases evaluating the applicant's estimates of effluent releases. Guidance determining the acceptability of the liquid and gaseous source terms and associated system parameters applied in their development is given in SRP Section 11.2 for liquid effluents, SRP Section 11.3 for gaseous effluents, and SRP Section 11.4, "Solid Waste Management System," for wet and solid wastes generated as byproducts of the operation of the liquid waste management system (LWMS) and gaseous waste management system (GWMS). The sources of radioactivity include:

- ~~A. Boiling water reactor (BWR) gaseous~~A. Gaseous wastes (noble gases, radio-iodine, particulates, carbon-14, and tritium);) consisting of offgases from the primary coolant, steam generator blowdown treatment system; offgases from the main condenser evacuation system and turbine gland sealing systems, ~~steam and liquid;~~ leakage to containment, ~~radwaste, turbine, fuel handling and, service, auxiliary buildings, and ventilation system exhausts from buildings having the potential for containing radioactive materials.~~
- ~~B. BWR liquid wastes, consisting of leakage of equipment and floor, and turbine building drains from buildings housing equipment and components that may contain radioactive fluids; contaminated liquids produced by plant operations, such 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, radio-iodine, 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.~~materials. The presence and concentration of radioactive materials in primary coolant is also expected to account for the type of primary coolant chemistry being proposed, such as lithium hydroxide with or without boron, and zinc and hydrogen injection, as defined by the applicant.
- ~~D. PWR liquid~~B. Liquid wastes, (dissolved or entrained noble gases, radio-iodine, particulates, carbon-14, and tritium) consisting of primary coolant processed to remove radioactive materials and, if applicable, to control boron concentration (shim bleed); leakage collected in equipment and floor drains from buildings housing equipment and components that ~~may~~ contain radioactive process fluids; steam generator blowdown and blowdown treatment; condensate demineralizer regenerant solutions; contaminated liquids from anticipated plant operations, such as resin sluices, filter backwashes, ultrasonic resin cleaning rinses, reverse

osmosis reject streams, decontamination solutions, disposition of laboratory samples and sampler inses; plant sampling station drains; and detergent wastes.

C. Liquid wastes (dissolved or entrained noble gases, radio-iodine, particulates, carbon-14, and tritium) consisting of steam generator blowdown discharges and releases from steam generator blowdown and blowdown treatment systems based on secondary coolant concentrations expected during normal operations, AOOs, and design basis accident conditions, or at default activity levels or steam generator leakage rates derived from TS for secondary coolant. Other sources of liquid wastes may include discharges from auxiliary steam systems where those systems interface with PWR main steam systems and could become contaminated following the rupture of steam generator tubes.

D. In recognition of differences between and among PWR and BWR plants, the review will consider design features or processes that would affect the development of the radioactive source terms. Among other considerations, the review should address the production rate of tritium and operational features governing its inventory in primary and secondary coolant; radioactivity removal rates for U-tube and once-through steam generators; containment internal cleanup systems; waste gas input to pressurized holdup decay tanks, with and without charcoal beds; frequency and duration of containment purges; main condenser air ejector exhaust system; main condenser air in-leakage and mechanical vacuum pump; turbine gland sealing system; ratio of condensate demineralizer flow rate to steam flow rate; types and number of charcoal delay beds; and type of BWR condenser tubing alloy. While NUREG-0016, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors (BWRs)," NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWRs)," and ANSI/ANS 18.1-1999 provide information on differences between PWR and BWR design features that should be considered in developing radioactive source terms, the applicant is responsible for ensuring that the information is consistent with the above NRC and industry guidance or providing the basis for using different RWMS design features and parameters in characterizing cleanup processes for gaseous and liquid streams.

2. Additional Information for 10 CFR Part 52 Applications: Additional information will be ~~presented dependent~~ provided by the applicant depending on the type of application ~~being submitted for review~~. For a COL application, the additional information ~~is dependent~~ depends on whether the application references an ESP, a DC, both, or neither. Information requirements are prescribed within the "Contents of Application" sections of the applicable ~~Subparts~~ subparts to 10-CFR Part 52.

3. COL Action Items and Certification Requirements and Restrictions: For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

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For a COL application referencing a DC, a: A COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced

DC. The review should ensure that plant design features of the certified design are maintained in the COL application and that, if requested, the 10 CFR Part 52 process for seeking exemptions, changes, and departures is observed in changing Tier 1, Tier 2, and Tier 2\* information. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC and how they are being addressed under plant and site-specific conditions.

4. ESP Application Reviews: For an ESP application, submitted under 10 CFR Part 52, Subpart A, the review is limited to the information forming the basis of the radioactive effluent source terms, as defined by selected reactor technologies (e.g., based on one design, or a plant parameter envelope approach based on two or more designs) in bounding radioactive liquid and gaseous effluents for all defined release points. The application should provide enough information for the staff to conclude that the application provides a bounding assessment in demonstrating the capability to comply with the regulatory requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I design objectives. Accordingly, the review should ensure that physical attributes (relevant to the review conducted under this SRP section) of the site that could affect the design basis of systems, structures, and components (SSCs) that are important to safety or risk significant are reflected in the site characteristics, design parameters, and conditions stipulated in the ESP, including COL action items.

## Review Interfaces

Other SRP sections interface with this section as follows:

1. The reviewer responsible for the review of the effectiveness of the radwaste systems will use the primary and secondary coolant concentrations calculated using the above guidance, as inputs ~~for evaluation in evaluating the performance~~ of the ~~liquid waste system, under LWMS using the guidance in~~ SRP Section 11.2, and the ~~gaseous waste systems, under GWMS using the guidance in~~ SRP Section 11.3. The purpose of the evaluation is to determine if these systems can adequately treat primary and secondary coolants and reactor steam such that the associated radioactive liquid and gaseous effluents meet the ~~dose numerical~~ design objectives and ALARA provisions of Appendix I to 10 CFR Part 50, and liquid and gaseous effluent concentration limits of 10 CFR Part 20, Appendix B, Table 2, Columns 1 and 2 and Note 4 at the point of release in unrestricted areas.
- 2.- The reviewer responsible for the review of the effectiveness of ~~the radwaste systems—~~ RWMS will coordinate with the review of radiation protection design features using the guidance in SRP Section 12.2 in selecting primary coolant and reactor steam concentrations used for the design basis source terms.
3. The reviewer responsible for the review of the effectiveness of RWMS monitoring instrumentation will coordinate its review under with the review conducted using the guidance in SRP Section 11.5, “Process and Effluent Radiological Monitoring Instrumentation and Sampling Systems,” ~~the~~ in confirming the adequacy of monitoring and control ~~provisions measures~~ for all ~~the applicable~~ identified effluent release points ~~identified in Subsection I.1, above.~~ The review will consider monitoring and sampling

methods used for the detection of radioactivity in non-radioactive systems to prevent unmonitored and uncontrolled releases of radioactive materials to the environment.

~~The specific acceptance criteria and review procedures are contained in the referenced SRP sections.~~

- ~~4. Other review interfaces will be identified as mandated by specific applications. In these instances, the staff's evaluation process is addressed in SRP Sections 3.11, 12.2, and 15.0.3.~~

## II. ACCEPTANCE CRITERIA

### Requirements

Acceptance criteria are based on meeting the relevant requirements of the following ~~Commission~~ regulations of the NRC:

- ~~1.-~~ 10 CFR Part 20, as it relates to determining the operational source term that is used in calculations associated with potential radioactivity in ~~effluents to unrestricted areas. Part 20 is not applicable to an ESP application~~ liquid and gaseous effluents to unrestricted areas. While 10 CFR Part 20 is not applicable to an ESP application, 10 CFR 52.17(a)(1)(ii) requires an ESP applicant to provide enough information for the staff to conclude that the application provides a bounding assessment in demonstrating the capability to comply with the regulatory requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I design objectives. The information should describe physical attributes of the site, as relevant to the review conducted under this SRP section, that could affect the design basis of SSCs that are important to safety or risk significant are reflected in the site characteristics, design parameters, and conditions stipulated in the ESP, including COL action items.
- ~~2.-2.~~ 10 CFR 50.34(a) and (b), 10 CFR 52.47(a)(5), 10 CFR 52.47(a)(8), 10 CFR 52.79(a)(3), and 10 CFR 52.79(a)(1)(i) and (ii) which require applications for OLs, DCDs, and COLs to include the kinds and quantities of radioactive materials expected to be produced and released during normal operations and AOOs to be within the limits of 10 CFR Part 20 and 10 CFR Part 50, Appendix I design objectives.
- ~~3.~~ 10 CFR Part 50, Appendix I, as it relates to determining the operational source term that is used in calculations associated with potential radioactivity in liquid and gaseous effluents considered in the context of numerical guides for design objectives and limiting conditions for operation to meet the ALARA criterion "~~as low as is reasonably achievable~~" (ALARA) for radioactive ~~material~~ materials contained in LWR effluents.
- ~~3.~~ ~~4.~~ 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 60-(GDC), as it relates to determining the operational source term that is used in calculations associated with potential radioactivity in liquid and gaseous effluents to released into unrestricted areas, such that a nuclear power unit design shall include the means to control suitably the releaser releases of radioactive materials in gaseous and liquid effluents provided produced during normal reactor operation, including anticipated operational occurrences. and AOOs. While GDC\_60 is not applicable to an ESP application, an

applicant is required to provide information characterizing anticipated levels of radioactivity in effluents under 10 CFR 52.17(a)(1)(ii).

5. 10 CFR Part 50, Appendix A, GDC 61, as it relates to the design of facilities and shielding used for the safe storage and handling of radioactive materials and other systems containing radioactivity for the purpose of assessing radiological safety under normal operations and postulated accident conditions.

### SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the ~~NRC's~~NRC regulations identified above are ~~as follows for the review described in this SRP section set forth below.~~ The SRP is not a substitute for ~~the NRC's~~NRC regulations, and compliance with it is not required. However, an applicant is required to identify differences between ~~the~~this SRP section and design features, analytical techniques, and procedural measures proposed for ~~it~~the facility ~~and the SRP acceptance criteria,~~ and ~~evaluated~~discuss how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of ~~compliance~~complying with the ~~NRC regulations.~~regulations that underlie SRP acceptance criteria and meet NRC regulatory requirements under 10 CFR 50.34(h), 10 CFR 52.17(a)(1)(xii), 10 CFR 52.47(a)(9), and 10 CFR 52.79(a)(41) for ESP, CP, DC, OL, and COL applications.

In general, ~~the~~reactor coolant and steam source terms used as the design basis for expected releases have been found acceptable if these values are determined using models and parameters that are consistent with NRC and industry guidance. The guidance includes: RG 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," NUREG-0016 (BWR-GALE code) or and NUREG-0017 (as the basis of the BWR-gaseous and liquid effluent (GALE) and PWR-GALE code) codes, and the industry guidance provided in ANSI/ANS 18.1-1999, as adjusted to reflect specific design features.

These models and parameters are based on operating experience with large, existing PWRs. Differences in design features and operating characteristics of PWRs or BWRs should be evaluated and used to make specific adjustments to the parameters used in the PWR-GALE Code and BWR-GALE Code or in ANSI/ANS 18.1-1999. Differences may also exist in the operational configuration and sequence of treatment of waste management systems for various process streams and effluent releases. The use of PWR-GALE86 or BWR-GALE86 in place of the earlier PWR-GALE Code (see NUREG-0017) or BWR-GALE Code (see NUREG-0016) is endorsed by Interim Staff Guidance (ISG) DC/COL-ISG-5, "GALE86 Code for Calculation of Routine Radioactive Releases in Gaseous and Liquid Effluents to Support Design Certification and Combined License Applications." Whenever adjustments are made to parameters used in either code, applicants should provide sufficient information for the staff to conduct an independent evaluation of the applicant's use of alternative code parameters.

The relevant RGs and ISG are as follows:-



- ~~Regulatory Guide 1.110, 1.~~ RG 1.110, “Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors,” as it relates to the cost-benefit analysis for radioactive waste management systems and equipment.

~~Regulatory Guide~~

- 2. RG 1.112, “Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors.” as it relates to the method of calculating ~~releaser~~releases of radioactive materials in liquid and gaseous effluents from nuclear power plants.

~~Regulatory Guide 1.140,~~

- 3. RG 1.140, “Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants,” as it relates to the design, testing, and maintenance of normal ventilation exhaust system air filtration and adsorption units at nuclear power plants.

4. DC/COL-ISG-5, Interim Staff Guidance on NUREG-0800, SRP Section 11.1.

Specific SRP acceptance criteria are as follows:

- 1.- All normal operation and ~~potential~~AOO sources of radioactive ~~effluent~~liquid and gaseous effluents delineated above in Subsection I will be considered.
- 2.- For each source of liquid and gaseous waste considered above in Subsection I.1, (as described in SRP Sections 11.2, 11.3, and 11.3 for RWMS), the volumes ~~and,~~ concentrations, or release rates of radioactive ~~material~~materials given for normal operation and ~~anticipated operational occurrences~~AOOs should be developed using methods that are consistent with those given in ~~NUREG-0016 or, NUREG-0017, or ANSI/ANS 18.1-1999.~~
- 3.- Decontamination factors ~~for inplant control measures~~ used to reduce gaseous effluent releases to the environment, such as noble gases from decay tanks, iodine removal systems, and high-efficiency particulate air (HEPA) filters for building ventilation exhaust systems and containment internal cleanup systems should be consistent with those given in ~~Regulatory Guide~~RG 1.140. The building mixing efficiency for containment internal cleanup should be consistent with ~~NUREG-0016, NUREG-0017, ANSI/ANS 18.1-1999,~~ or the basis for different containment cleanup parameters should be documented. The review should evaluate the types and characteristics of filtration systems and adsorbent media proposed to treat gaseous process and effluent streams, including type of charcoal media (grade, mesh size, and bulk density); number and volume of charcoal decay tanks; dynamic adsorption coefficients for charcoal media and retention times; removal efficiencies for HEPA filtration systems, taking into account the expected physical, chemical, and radiological properties of gaseous process and effluent streams, and processing flow rates.
- 4.- Decontamination factors ~~for inplant control measures used~~applied to reduce liquid effluent releases to the environment, ~~such as filters, demineralizers and evaporators,~~ should be consistent with those given in ~~NUREG-0016 or, NUREG-0017, or ANSI/ANS 18.1-1999.~~ The review should evaluate the types and characteristics of filtration systems, ion-exchange resins, and adsorbent media proposed to treat liquid process and effluent streams, including number and volume of ion-exchange resin column

or activated charcoal bed; types and volumes of ion-exchange resins or activated charcoals; removal efficiencies and decontamination factors, taking into account the expected physical, chemical, processing flow rates, and radiological properties of liquid process and effluent streams.

5. ~~Radwaste augments used in the calculation of effluent releases to the environment are consistent with the findings of a 5. The RWMS component design augmentations used in cost-benefit analysis, which may should be performed using consistent with the guidance of Regulatory Guide RG 1.110. The provisions that require requirements to conduct a cost-benefit analysis are stated and identify acceptable cost-benefit ratios in assessing the acceptability of such analyses are given in Section II.D of Appendix I to 10 CFR Part 50. Section II.D of Appendix I requires that the applicant demonstrate that the plant design includes all items of reasonably demonstrated technology which, when added to RMWS sequentially and in order of diminishing return, will effect a reduction in releases of radioactive materials and cumulative population doses within an 80-km (50-mile) radius of the plant.~~
6. ~~Effluent6. Liquid and gaseous effluent~~ concentration limits at the boundary of the unrestricted area do not exceed the values specified in Table 2 of Appendix B to 10 CFR Part 20 and Note 4 for radionuclide mixtures.
7. ~~The~~ The primary and secondary coolant and steam source terms result, and those of associated plant systems and components, used in meeting characterizing liquid and gaseous effluents, confirm that resulting doses comply with the design objectives for doses in unrestricted areas as set forth in Appendix I to 10 CFR Part 50, Sections II.A to II.C.
8. ~~For~~ In evaluating the coolant source terms, the applicant should provide the relevant information in the SAR application as required by 10 CFR 50.34, ~~and (b)(3).~~ 10 CFR 50.34a. ~~This technical information, and 10 CFR 52.79(a)(3).~~ The FSAR should include all the basic data listed in Appendix A (BWRs) and Appendix B (PWRs) to Regulatory Guide of RG 1.112 in order to calculate the releases of radioactive material materials in liquid and gaseous effluents (the source terms). An acceptable method for satisfying the criteria given in items 1 through 5 (above) consists of using the Gaseous and Liquid Effluent (PWR-GALE) Computer Code and the source term parameters given code or BWR-GALE code, as adjusted to reflect specific design features. Differences in design features and operating characteristics should be evaluated and used to make specific adjustments to the parameters used 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, or ANSI/ANS 18.1-1999. Differences may also exist in the operational configuration and sequence of treatment among RWMS equipment for various process streams and in treating effluents prior to being released to the environment. Whenever adjustments are made to parameters used in the PWR-GALE or BWR-GALE code, applicants should provide sufficient information for the staff to conduct an independent evaluation of the applicant's use of alternative code parameters.
9. ~~If~~ The design basis reactor coolant and reactor steam source terms should be based on:

- A. an offgas rate of 3.7 megabecquerels per second per megawatt thermal (MBq/s per MWt) (100 microcuries (μCi)/s per MWt) measured or estimated after a 30-minute delay for BWRs;
- B. 0.25 to 1 percent fuel cladding defects for PWRs; and
- C. technical specification limits for halogens (I-131 dose equivalent) and noble gases (Xe-133 dose equivalent), whichever are most limiting when compared to criteria (1) and (2) above, as applied in analyses conducted using the guidance in SRP Sections 11.2 and 11.3 and SRP Chapter 15.

Activation source terms, including activated corrosion products, should be based on measurements and experience gained from operating BWR and PWR plants of similar design, including TS for primary and secondary coolant concentrations. ANSI/ANS 18.1-1999 is based on such experience and provides information that can be used as a basis for estimating neutron activation source terms. When operating measurements are used, extrapolation of data to equilibrium conditions may be needed to estimate ultimate activation source terms. See SRP Section 12.2 for additional guidance.

10. When the applicant's ~~calculational~~ calculation technique or any source term parameter differs from that given in ANSI/ANS 18.1-1999, NUREG-0016, or NUREG-0017, or ANSI/ANS 18.1-1999, they should be described in with sufficient detail, and the ~~bases for~~ basis of the ~~methods~~ alternate method and/or model parameters used should be provided to allow the staff to conduct an independent evaluation.

### Technical Rationale

The technical rationale for application of these acceptance criteria is to ~~determine~~ define the primary and secondary coolant source ~~term~~ terms as ~~a precursor to~~ precursors in calculating radioactivity ~~in levels in liquid and gaseous~~ effluents. In addition, this information is used to assess the adequacy and performance of RWMS in treating process streams and controlling amounts of radioactivity discharged in the environment. The technical rationale for ~~application of the acceptance criteria for reviewing the radwaste treatment system above~~ considerations is discussed in the following paragraphs:

- 1.- 10 CFR Part 50, Appendix I, provides numerical ~~guidance~~ guides on offsite individual doses due to liquid and gaseous effluents and air doses ~~due to (as beta and gamma absorbed dose rates)~~ due to gaseous effluents. It also provides an acceptance criterion for cost-benefit analysis as it relates to population doses due to liquid and gaseous effluents (Section II.D of Appendix I). Conformance with Section II.D of Appendix I demonstrates that the plant design includes all items of ~~established modern~~ reasonably demonstrated technology ~~for reducing the cumulative population dose due that, when added to reactor makeup water storage in order of diminishing return, will effect a reduction in releases of radioactive materials from the reactor and cumulative population doses~~ to ALARA levels ~~of Appendix I.~~

~~The calculations~~Calculations using the ~~Gaseous and Liquid Effluent (PWR-GALE) Computer Code and code~~ or the BWR-GALE code and source term parameters, as given in NUREG-0017 or NUREG-0016 and NUREG-0017 for BWRs and PWRs, respectively, take into account moderncurrent technology and the availability of equipment based on that technology to reduce the radioactivity levels in liquid and gaseous waste management system source terms process streams. The assumptions used in the calculations that are, based on the performance of modernsuch equipment, have a driving influencean impact on the design parameters used forin modeling the performance of radwaste management systems reviewed in SRP Section 11.2, “Liquid Waste Systems,” and in SRP Section 11.3, “Gaseous Waste Systems.”. If either code is modified to model specific design features, the modifications should be described in sufficient detail that they can be reviewed. If an alternate calculation model is proposed by the applicant, it should be described in sufficient detail, and the bases of all parameters used in the model should be described to allow the staff to conduct an independent evaluation.

Meeting the coolant source term calculation criteria of SRP Section 11.1 provides reasonable assurance that the system designs reviewed in SRP Sections 11.2 and 11.3 will meet the effluent concentration limits in unrestricted areas specified in 10 CFR Part ~~20,~~ the requirements (Appendix B, Table 2, Columns 1 and 2, and Note 4) and the ALARA objectives of 10 CFR 50.34a as they relate to the adequacy of design information for radwaste management systems; GDC 60 and 61 of 10 CFR Part ~~50,~~ Appendix A; and the public dose limitationsnumerical criteria of 10 CFR Part 50, Appendix I.

- 2.- GDC 60 requires, in part, that the nuclear power unit design ~~shall~~include the means to control ~~suitably the releasereleases~~ of radioactive materials in gaseous and liquid effluents produced during normal reactor operation, ~~including anticipated operational occurrences and AOOs.~~

GDC 60 ~~specifiesrequires~~ that sufficient holdup capacity ~~shall~~be provided for the retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations ~~onupon~~ the release of ~~such~~effluents to the environment. The holdup capacity also provides time to allow ~~the shorter-lived isotopes a chanceradionuclides~~ to decay before they are further processed or released to the ~~atmosphereenvironment.~~ Acceptable holdup times ~~are used, applied~~ in ~~the~~ source term calculations, are provided in NUREG-0016 ~~and,~~ NUREG-0017, or ANSI/ANS 18.1-1999.

Meeting the requirements of GDC 60 provides reasonable assurance that releases of radioactive materials, during normal operation and AOOs of ~~the~~ radwaste processing systems ~~and during anticipated transients,~~ will not result in offsite radiation doses exceeding the ~~limitsnumerical design objectives~~ specified in 10 CFR Part 50, Appendix I, and ~~the~~ effluent concentration limits infor unrestricted areas ~~exceeding the limits~~ specified in 10 CFR Part 20 (Appendix B, Table 2, Columns 1 and 2) and Note 4 for mixtures of radionuclides.

3. GDC 61 requires that the facility design include shielding used for the safe storage and handling of radioactive materials, and other systems containing radioactivity, for the

purpose of assessing radiological safety under normal operations and postulated accident conditions.

Inventories of the amounts of radioactive materials contained in RWMS must be determined for the purpose of assessing whether the design of RWMS assures radiological safety under normal operations and postulated accident conditions. NUREG-0016, NUREG-0017, or ANSI/ANS 18.1-1999 describe acceptable methods in determining the inventories of radioactive materials in RWMS components during normal operations, which could be modified to develop source terms for postulated accidents.

Meeting this requirement of GDC 61 provides reasonable assurance that the necessary information is available to identify the amounts of radioactive materials contained in RWMS and assess the radiological impacts during postulated accidents. Acceptable NRC guidance and methods are described in SRP Sections 2.4.13, "Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters;" SRP 11.2 using Branch Technical Position (BTP) 11-6, "Postulated Radioactive Releases Due to Liquid-containing Tank Failures;" SRP 11.3 using BTP 11-5, "Postulated Radioactive Releases Due to a Waste Gas System Leak or Failure (Former Section 11.3 BTP has been separated into an individual sections)," and the analysis of RG 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants," in assigning safety classifications to RWMS for design purposes.

### III.- REVIEW PROCEDURES

~~The reviewer will select material from the procedures described below, as may be appropriate for a particular case.~~

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's ~~evaluation of how approach and whether~~ the proposed ~~alternatives provide~~ alternative provides an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

1. Programmatic requirements: Commission regulations and policy mandate a number of specific "programs" applicable to certain SSCs. This SRP section does not directly address SSCs. The NRC regulations, under 10 CFR 50.36a and 10 CFR Part 50, Appendix I, require that each OL contain a TS that defines "...the limits, operating conditions, and other requirements imposed upon facility operation for the protection of public health and safety..." The applicant's analysis developed in SRP Section 11.1.1. of the application should be consistent with guidance for development of TS and the associated offsite dose calculation manual and process control program, as mandated operational programs using the guidance in SRP Section 13.4, "Operational Programs."
2. For DC applications submitted under 10 CFR Part 52, the applicant is required to (1) address the proposed technical resolution of unresolved safety issues (USIs) and medium- and high-priority generic safety issues (GSIs) that are identified in the version of NUREG-0933, "Resolution of Generic Safety Issues (Formerly entitled "A Prioritization of Generic Safety Issues")," current on the date 6 months before application and that are

technically relevant to the design; (2) demonstrate how the operating experience insights have been incorporated into the plant design; and, (3) provide information necessary to demonstrate compliance with any technically relevant portions of the Three Mile Island (TMI) requirements set forth in 10 CFR 50.34(f), except paragraphs (f)(1)(xii), (f)(2)(ix), and (f)(3)(v), as stipulated under 10 CFR 52.47(a)(21), 10 CFR 52.47(a)(22), and 10 CFR 52.47(a)(8), respectively. For COL applicants, the parallel requirements, with exception to the provision on operating experience and plant design, are described in 10 CFR 52.79(a)(20) and 10 CFR 52.79(a)(17). These cross-cutting review areas should be addressed by the reviewer for each technical subsection and relevant conclusions documented in the corresponding section of the staff's Safety Evaluation Report (SER).

3. In the review of the mathematical models and parameters given in the SARapplication to calculate primary and secondary coolant concentrations, the reviewer compares parameters and calculations given in the SARapplication with the models and parameters given in ANS/ANS 18.1-1999, NUREG-0016, or NUREG-0017, or ANS/ANS 18.1-1999, modified as necessary to reflect the design and operating parameters of the proposed reactor design. If the SARapplication includes models or parameters to estimate reactor coolant and steam concentrations that differ from these reports the guidance, the parameters and calculations used should be substantiated by the applicant. The preferred method of substantiation is by presentation of operating data from similar reactors with information justifying the basis for any adjustments taking into account the design features of plant-specific conditions.

4.

4. he reviewer performs an independent calculation of the primary and secondary (PWR)-coolant concentrations using the guidance provided in of NUREG-0016, NUREG-0017, or ANS/ANS 18.1-1999, modified as necessary to reflect the parameters of plant-specific conditions. The applicant should provide sufficient information for the staff to conduct an independent evaluation of the applicant's use of alternative code parameters. The review should consider differences in calculation methods and selection of code parameters chosen because of differences in design and operating features of the proposed design when compared to either code.

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5.

In the calculation, the reviewer will use the applicant's values as given in the SARapplication for the following key parameters: design core thermal power level, steam flow rate, mass of primary coolant mass, mass of liquid in reactor vessel, mass of water in each steam generator and number of steam generators, steam generator blowdown rates, primary coolant letdown rates, and coolant purification rates, among others. RG 1.112 (Appendix A for BWRs, Appendix B for PWRs), NUREG-0016, or NUREG-0017 provide guidance on plant data needed to develop input parameters for either code. The staff may use alternative parameters for the purpose of assessing whether the applicant's values provide a reasonable level of conservatism in assumptions and results. Note: The source terms referenced in the this section are used for both the review of the SARapplication and environmental report, and for the staff's preparation of the SER and environmental impact statement.

#### Review Procedures Specific to 10 CFR Part 52 Application Type

- A. Early Site Permit Reviews. Subpart A to 10 CFR Part 52 specifies the requirements applicable to the Commission's review of an ESP application. Information required in an ESP application includes a description of the site characteristics and design parameters of the proposed site. ~~The scope and level of detail of review of data parallel that used for a CP review.~~

~~For review of an ESP application, staff will evaluate the postulated design parameter associated with the normal operational source term.~~

For the review of an ESP application, staff will evaluate the postulated design parameters associated with the normal operational and AOO source terms. The staff will confirm the approach used by the applicant in developing the annual average liquid and gaseous effluent source terms. For a coolant source term based on a single type of reactor design, the staff will confirm that the applied source term is consistent with that presented in the current revision of the DC or other selected reactor technology. For a coolant source term based on two or more types of reactor designs, the staff will confirm that the source term, as a plant parameter envelope, is consistent with that presented in the current revision of each DC, or other selected reactor technologies, and conservatively bounding over all expected radionuclides and estimated releases. The staff will confirm that the applicant has provided enough information for the staff to conclude that the application provides a bounding assessment in demonstrating the capability to comply with the regulatory requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I design objectives.

In the absence of certain circumstances, such as a compliance or adequate protection issue, 10 CFR 52.39 precludes the staff from imposing on an ESP new site characteristics, design parameters, or terms and conditions ~~on the early site permit~~ for items approved in the review of the ESP application at the COL stage. Accordingly, the reviewer should ensure that ~~all~~ physical attributes (pertinent to the review conducted in this SRP section) of the site that could affect the design basis of SSCs that are important to safety or risk-significant are reflected in the site characteristics, design parameters, or terms and conditions ~~on the early site permit~~ stipulated in the ESP, including COL action items.

- B. Standard Design Certification Reviews. For the review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., ~~interface requirements~~ system interfaces and site parameters), set forth in the ~~final safety analysis report (FSAR)~~ application, meets the acceptance criteria. ~~DCs have referred to the FSAR as the design control document (DCD).~~ The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure that these COL action items are addressed during the review of a COL application, they ~~should~~ would need to be added to the DC

FSAR application in ensuring that such COL action items are properly addressed by other COL applicants using the same design.

- e.-C. Combined License Reviews. For the review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or, other NRC approvals (e.g., manufacturing license, site suitability report or topical report-), or none of these. The staff will confirm that the applicant has properly incorporated the relevant information from the DC or that of another design into the COL application, addressed all COL action items associated with specific design aspects of SSCs (e.g., balance of plant topics not covered in the design) left to the COL applicant, and considerations driven by site-specific features.

For the review of a COL application relying on a DC, 10 CFR 52.63 precludes the staff from imposing new requirements on design certifications unless it is deemed necessary to bring the certification into compliance with NRC regulations, provide adequate protection of public health and safety, or preserve common defense and security. A DC has finality for issues resolved at the DC stage, and the staff can only make changes to this information if it meets one of the standards in 10 CFR 52.63. If a COL applicant seeks to make changes to information within the scope of a DC (as Tier 1, Tier 2, or Tier 2\* information), then it must also follow the appropriate change process in Section VIII of the DC. Accordingly, the reviewer should ensure that plant design features of the certified design are maintained in the COL application and that, if requested, the 10 CFR Part 52 process for seeking exemptions, changes, and departures is observed in changing Tier 1, Tier 2, and Tier 2\* information. These provisions apply only to those portions of the DC that are incorporated by reference in the COL and do not apply to site-specific design features that are within the scope of the COL.

#### IV.- EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the staff's safety review and calculations (if applicable) analysis conducted in accordance with the staff's technical review approach described in the SRP Introduction, support conclusions of the following typetypes to be included in the staff's safety evaluation report— SER. When programmatic elements are used to assess design adequacy and effects on the development of radioactive source terms, the reviewer confirms that the applicant has properly identified those elements of the program in DC and COL FSAR Section 13.4 (Table 13.4-x), as supplemental elements to an existing program or as the addition of a new program.

The reviewer also states the bases for those conclusions-, as listed below:

1. Sufficient~~The staff concludes that sufficient~~ information has been provided by the applicant so that the requirements of 10-CFR-Part 50, Sections 50.34 and 10 CFR 50.34a have been met. The reviewer responsible for review of effectiveness of radwaste systems will provide a summary statement on the acceptability of radioactive source terms used as design parameters for the waste management systems ~~will be made~~



~~under SAR Sections~~SER Section 11.2, “Liquid Waste Systems,” and SER Section 11.3, “Gaseous Waste Systems.”

- ~~2. The staff has reviewed the applicant’s source term and has determined that the values are consistent with the guidance provided in ANSI/ANS 18.1-1999. The staff~~The staff concludes that the liquid and gaseous source terms are acceptable and that their use in calculating doses associated with liquid and gaseous effluents will meet the regulatory requirements with respect to offsite radiation under 10 CFR Part 20 for effluent concentration and dose limits and effluent concentration limits for members of the public, and 10 CFR Part 50, Appendix I design objectives and ALARA provisions. The review includes the bases of the source terms for both the design basis and normal operations and AOs. The staff confirms that the source terms were developed using the guidance provided in RG 1.112; NUREG-0016, NUREG-0017, or ANSI/ANS 18.1-1999; and that specific adjustments were made in consideration of the specific design and operating features of the proposed reactor design. The staff confirms that the applicant has provided sufficient information in justifying changes in the use of input parameters for the reactor design.

~~For an ESP application, the finding to be made in SRP Sections 11.2 and 11.3 should be made such that Appendix I limits can be met.~~

- ~~3. The staff concludes that the liquid and gaseous source terms are acceptable and that their use in calculating doses associated with accident conditions will meet the regulatory requirement of GDC 61. Meeting GDC 61 provides the means to determine the amounts of radioactive materials contained in RWMS and assess the radiological impacts during postulated accidents. The staff determined that the applicant used the method and guidance described in SRP Sections 2.4.13, SRP 11.2 using BTP 11-5, SRP 11.3 using BTP 11-6, and the analysis of RG 1.143 in assigning the safety classifications of RWMS for design purposes.~~
- ~~4. The staff has reviewed the proposed augmentation of programmatic elements in assessing the adequacy of the design and resulting effects on the development of associated radioactive source terms. The staff’s evaluation and conclusion of the acceptability of the augmented programmatic elements are addressed in SER Section 13.4, “Operational Programs,” and relevant SER sections for the systems and components identified in the supplemental or new programmatic elements.~~
- ~~5. For an ESP application, the staff confirms that the applicant has provided enough information for the staff to conclude that the application provides a bounding assessment in demonstrating the capability to comply with the regulatory requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I design objectives. The staff’s evaluation confirmed that physical attributes of the site that could affect the design basis of SSCs (in the context of this SRP section and SRP Sections 11.2 and 11.3) that are important to safety or risk significant are reflected in the site characteristics, design parameters, and conditions stipulated in the ESP, including COL action items. The staff’s findings are presented in SER Sections 11.2 and 11.3 in addressing the requirements of 10 CFR Part 20 for effluent concentration limits and dose limits for members of the public, and 10 CFR Part 50, Appendix I design objectives and ALARA provisions. The staff confirms that the approach used by the applicant in developing the annual average liquid and gaseous effluent source terms is consistent with the identified~~

type of reactor design, as presented in the DC or other selected reactor technology. For a coolant source term based on two or more types of reactor designs, the staff confirmed that the source term, as a plant parameter envelope, is consistent with that presented in the DC or other selected reactor technology and conservatively bounding over all expected radionuclides and estimated releases.

6. For DC and COL reviews, the findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this SRP section. For reviews of a COL application relying on a DC, the staff's findings confirm that plant design features of the certified design are maintained in the COL application and that, if requested, the 10 CFR Part 52 process for seeking exemptions, changes, and departures has been observed in changing relevant Tier 1, Tier 2 and Tier 2\*.

## V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of ~~DC applications and license~~ESP, CP, DC, OL, or COL applications submitted by applicants pursuant to 10-~~CFR Part 50 or and 10-CFR-Part-52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the~~The staff will use the method described herein to evaluate conformance with ~~Commission~~Commission's regulations as noted below. With respect to demonstrating conformance with the SRP, NRC regulations-

~~The provisions of state, in part, that the application must contain "an evaluation of the standard plant design against the SRP revision in effect six6 months before the docket date of the application." However, an applicant is required to identify differences between this SRP section apply to reviews of applications submitted six months or more after the date of issuance of this SRP section, unless superseded by and design features, analytical techniques, and procedural measures proposed for the facility, and discuss how the proposed alternatives to the SRP acceptance criteria provide acceptable methods in complying with regulations that underlie SRP acceptance criteria and meet NRC regulatory requirements under 10 CFR 50.34(h), 10 CFR 52.17(a later revision. (1)(xii), 10 CFR 52.47(a)(9), and 10 CFR 52.79(a)(41) for ESP, CP, DC, OL and COL applications.~~

## VI. REFERENCES

- ~~1. NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWRs)," current revision.~~
- ~~2. NUREG-0016, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors (BWRs)," current revision.~~
- ~~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."~~
1. ~~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 Is Reasonably Achievable' for Radioactive Material in Light Water Cooled Nuclear Power Reactor Effluents."~~
1. 10 CFR Part 20, "Standards for Protection Against Radiation."
- ~~2. 10 CFR Part 50, Section 20, Appendix B, "Annual Limits on Intake and Derived Air Concentrations of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage."~~
- ~~3. 10 CFR Part 20, "Subpart G - Control of Exposure from External Sources in Restricted Areas."~~
- ~~4. 10 CFR Part 20, "Subpart H - Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas."~~
6. 10 CFR 50.34, "Domestic Licensing of Production and Utilization Facilities - Contents of Applications; Technical Information."
7. 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."
- ~~2. Regulatory Guide 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluent from Light Water Cooled Power Reactors."~~
8. 10 CFR Part 50, Appendix A, General Design Criterion 60, "Control of Releases of Radioactive Materials to the Environment."
9. 10 CFR Part 50, Appendix A, General Design Criterion 61, "Fuel Storage and Handling and Radioactivity Control."
- ~~10. 10 CFR Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low As Is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents."~~
- ~~11. 10 CFR Part 52, "Early Site Permits; Standard Design Licenses, Certifications, and Combine Licenses Approvals for Nuclear Power Plants."~~
12. ANSI/ANS-18.1-1999, "American National Standard Radioactive Source Term for Normal Operation of Light Water Reactors."

13. DC/COL-ISG-5, "GALE86 Code for Calculation of Routine Radioactive Releases in Gaseous and Liquid Effluents from Boiling-Water-Reactors and Pressurized-Water-Reactors to Support Design Certification and Combined License Applications."
14. NUREG-0016, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors."
15. NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors."
16. NUREG-0933, "Resolution of Generic Safety Issues (Formerly entitled "A Prioritization of Generic Safety Issues")."
17. RG 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water- Cooled Nuclear Power Reactors."
18. RG 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors."
19. RG 1.140, "Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants."
20. RG 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light Water Cooled Nuclear Reactor Power Plants."
21. RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors."

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**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.

**PUBLIC PROTECTION NOTIFICATION**

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

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**SRP Section 11.1**  
**Description of Changes**

**Section 11.1 “COOLANT SOURCE TERMS”**

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in SRP Section 11.1, Revision 3, dated March 2007. See the Agencywide Documents Access and Management System (ADAMS) Accession No. ML070790010.

The section’s title was revised to “Coolant Source Terms” in recognition that radiological considerations addressed in this SRP section focus on radioactivity that originates only from reactor fuel and migration in primary and secondary coolants and reactor steam.

Editorial changes included adding new abbreviations in several places throughout this section and correcting grammatical errors. Other changes reflect the removal of redundant and repetitive information.

Technical changes incorporated in this revision include:

I. AREAS OF REVIEW

The areas of review section was revised by expanding the discussions on the development of source terms and their use in SRP Section 3.11 and SRP Chapters 11, 12, and 15. The discussion distinguishes source terms as radioactive materials expected during normal operations and AOOs, and design basis source terms. The source terms are used to:

1. confirm that radioactive liquid and gaseous effluents meet the numerical design objectives and ALARA provisions of Appendix I to 10 CFR Part 50, and liquid and gaseous effluent concentration limits of 10 CFR Part 20, Appendix B, Table 2, Columns 1 and 2 and Note 4 at the point of release in unrestricted areas.
2. derive inventories of radioactivity in system components, assess the adequacy of shielding in maintaining doses to workers and public ALARA, define ambient radiation exposure levels and zones, and confirm the proper placement of radiation monitoring equipment in plant areas and operating conditions and the design of ventilation systems provided for maintaining doses to workers ALARA, consistent with 10 CFR Part 20 requirements.
3. assess equipment qualifications and model releases under design basis accident conditions for evaluation against reactor siting criteria and control room radiological habitability requirements.
4. assess the radiological impacts during postulated accidents, as required in SRP Section 2.4.13, SRP 11.2 using BTP 11-6, SRP 11.3 using BTP 11-5, and the analysis of RG 1.143 in assigning safety classifications to RWMS for design purposes and compliance with GDC 61.
5. consider design features or processes that would affect the development of the radioactive source terms in recognition of calculation methods and assumptions

presented in NUREG-0016, NUREG-0017, and ANSI/ANS 18.1-1999, given differences between PWR and BWR plants.

6. provide a bounding assessment for ESP applications in demonstrating the capability to comply with the regulatory requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I design objectives.

## II. ACCEPTANCE CRITERIA

The acceptance criteria section was revised by providing clarification on methods used to derive radioactive source terms. The major revisions include:

1. Inclusion of revised staff guidance presented in: DC/COL-ISG-5, Interim Staff Guidance on NUREG-0800, SRP Section 11.1, "GALE86 Code for Calculation of Routine Radioactive Releases in Gaseous and Liquid Effluents to Support Design Certification and Combined License Applications." The clarification notes that the calculation methods presented in NUREG-0016 and NUREG-0017 have been updated in a newer version of the associated computer code, denoted as GALE86.
2. The underlying assumptions used in developing design basis reactor coolant and reactor steam source terms was expanded to consider TS limits for halogens (I-131 dose equivalent) and noble gases (Xe-133 dose equivalent), as applied in analyses conducted using the guidance in SRP Sections 11.2 and 11.3 and SRP Chapter 15.
3. The revision notes that this SRP section does not include a review of the generation of neutron-activated components, in-core neutron detectors, or spent-fuel and their associated source terms since they do not originate from primary and secondary coolants and reactor steam.

## III. REVIEW PROCEDURES

The review procedures section was updated in recognition of the revisions identified in the areas of review and acceptance criteria sections, as noted above.

The revision addresses the staff review and evaluation of proposed augmentation of programmatic elements in assessing the adequacy of the design and resulting effects on the development of associated radioactive source terms.

The revision provides guidance on the review of the proposed technical resolution of USIs and medium- and high-priority GSIs identified in the version of NUREG-0933 current on the date 6 months before application and that are technically relevant to the design; how operating experience insights have been incorporated into the plant design; and information necessary to demonstrate compliance with technically relevant portions of the TMI requirements.

The revision provides clarification in confirming that the application provides a bounding assessment in demonstrating the capability to comply with the regulatory requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I design objectives, taking into account the physical attributes of the site.

For COL applicants, expanded guidance identifies parallel requirements, with exception to the provision on operating experience and plant design, are described in 10 CFR 52.79(a)(20) and 10 CFR 52.79(a)(17), as stated in 10 CFR 50.34(f). These cross-cutting review areas should be addressed by the reviewer for each technical subsection, with the relevant conclusions documented in the corresponding SER section.

#### IV. EVALUATION FINDINGS

The evaluation findings section was revised by expanding the discussions on the results of the staff's evaluation and conclusion of acceptability against cited regulations and guidance. The revisions address:

1. compliance with 10 CFR Part 50, Appendix A, GDC 61, as it relates to the analyses conducted using the guidance in SRP Section 11.2 using BTP 11-6, and SRP Section 11.3 using BTP 11-5.
2. compliance with 10 CFR Part 20 requirements on liquid and gaseous effluent concentration limits and occupational radiation protection.
3. development of radioactive source terms using RG 1.112, NUREG-0016, NUREG-0017, or ANSI/ANS 18.1-1999 and whether specific adjustments are made in consideration of specific design and operating features of the proposed reactor design.
4. proposed augmentation of programmatic elements in assessing the adequacy of the design and resulting effects on the development of associated radioactive source terms.
5. confirmation that the approach used in an ESP application in developing effluent source terms, as a plant parameter envelope, is consistent with the identified type of reactor design and conservatively bounding over all expected radionuclides and releases.

#### V. IMPLEMENTATION

The implementation section was revised by expanding the discussions on the evaluation of ESP, DC, COL applications. The expanded discussion address differences between standard plant design features, COL applications, and SRP acceptance criteria, and provide guidance on the acceptability of alternative methods in complying with cited regulations and SRP acceptance criteria.

#### VI. REFERENCES

The following references were added in support of the expanded discussions presented in areas of review, acceptance criteria, and review procedures. The added references are:

1. 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."
2. 10 CFR Part 20, "Subpart G - Control of Exposure from External Sources in Restricted Areas."



3. 10 CFR Part 20, "Subpart H - Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas."
4. ANSI/ANS 18.1-1999, "American National Standard Radioactive Source Term for Normal Operation of Light Water Reactors."
5. DC/COL-ISG-5, "GALE86 Code for Calculation of Routine Radioactive Releases in Gaseous and Liquid Effluents from Boiling-Water-Reactors and Pressurized-Water-Reactors to Support Design Certification and Combined License Applications."
6. RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors."
7. NUREG-0933, "Resolution of Generic Safety Issues (Formerly entitled "A Prioritization of Generic Safety Issues")."