



# U.S. NUCLEAR REGULATORY COMMISSION

## STANDARD REVIEW PLAN

### 11.2 LIQUID WASTE MANAGEMENT SYSTEM

#### REVIEW RESPONSIBILITIES

**Primary** - Organization responsible for the review of the effectiveness of radwaste systems and health physics in meeting effluent concentration limits in unrestricted areas and dose limits for members of the public.

**Secondary** - Organization responsible for the review of the radwaste system design features, system capacities, and performance in processing and treating liquid waste streams before being discharged to the environment.

#### I. AREAS OF REVIEW

For reviews of early site permits (ESP), construction permits (CP), standard design certification (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 (Preliminary Safety Analysis Report (PSAR) or Final Safety Analysis Report (FSAR)) as it relates to the sources of radioactivity that are processed by the liquid waste management system (LWMS). For operating licenses (OL) or COLs that reference a DC, the staff confirms that the information accepted at the CP or standard DC stage is appropriately incorporated in the relevant sections of OL or COL applications, and that proposed departures are adequately justified and documented.

Draft Revision 5 – August 2014

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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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This Standard Review Plan (SRP) section addresses the evaluation of plant systems used to manage and treat process and effluent streams before being released from pressurized water reactors (PWRs) and boiling water reactors (BWRs). The staff's evaluation assesses whether an applicant demonstrates compliance with regulatory limits on liquid effluent discharges and associated doses to members of the public in ensuring that releases and doses are as low as reasonably achievable (ALARA).

In PWRs and BWRs, the LWMS is designed to ensure that liquids and liquid wastes produced during normal operation, including anticipated operational occurrences (AOOs), are handled, processed, stored, and released or routed to their final destination in accordance with the relevant NRC regulations. The review of the LWMS includes design features that are necessary for collecting, handling, processing, treating, releasing, storing, and disposing of liquid effluents.

This review encompasses, but is not limited to tanks, piping, pumps, valves, filters, demineralizers, mobile equipment connected to permanently installed systems, and any additional equipment that may be necessary to process and treat liquid wastes and route them to the point of discharge from the system.

The LWMS has been categorized as nonsafety-related and nonrisk-significant. Failure of subsystems must not compromise any safety-related system or component, nor may it prevent the safe shutdown of the plant. However, the failure of specific subsystems or components may have some impacts on the means to control and monitor liquid effluent releases and on compliance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20 regulations in controlling liquid effluent releases to unrestricted areas and doses to members of the public. The LWMS is relied on to treat and control releases of radioactive materials in liquid effluents to the environment; therefore, it has a direct impact in complying with 10 CFR Part 20 regulations. As such, the review of the LWMS must be sufficient to assure that the staff has reasonable assurance that public health and safety is adequately protected. The applicant's FSAR must provide sufficient information to confirm that any failure of essential subsystems will not compromise public health and safety under NRC regulations.

The review of the LWMS includes the design, design objectives, design criteria, methods of treatment, system interfaces, bypass routes to nonradioactive systems, expected releases, methods used to terminate or divert effluent releases, and calculation methods and principal parameters used in deriving effluent source terms and releases of radioactive materials in liquid effluents, including system piping and instrumentation diagrams (P&IDs) and process flow diagrams showing methods of operation that influence waste treatment.

The specific areas of review include the following topics:

1. Equipment design capacities, expected flow rates or volumes, source terms and radionuclide concentrations, expected decontamination factors or removal efficiencies for radionuclides, and holdup or decay time.
2. System design capacity, relative to the design and expected input flow rates and volume inventories, and the period of time the system is required to be in service to process normal waste flow rates and volumes.
3. Availability of standby equipment, alternate processing routes, and interconnections between permanently installed subsystems and skid-mounted processing equipment in

order to evaluate the overall system capability to meet anticipated demands imposed by major processing equipment downtime and waste volume surges resulting from AOOs.

4. Quality group classifications of structures, piping, and equipment and the bases governing design criteria (safety classifications and applicable codes and standards for natural phenomena and man-induced hazards) assigned using the guidelines of Regulatory Guide (RG) 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants," for liquids and liquid wastes produced during normal operation and AOOs.
5. Quality assurance (QA) provisions for radioactive waste management structures, systems, and components (SSCs) in support of design criteria using the guidelines of RG 1.143 for liquids and liquid wastes produced during normal operation and AOOs.
6. Provisions to prevent, control, and collect radioactive materials in liquids from tank overflows from all plant systems and the potential for tanks located outside of the reactor containment that could result in uncontrolled and unmonitored releases, and design features applied to mitigate the effects of a postulated tank failure, e.g., steel liners, sumps, drains, or walls in areas housing tanks and components, dikes and retention basins for outdoor tanks, and provisions to accommodate overflow conditions by routing flows to appropriate subsystems, using the guidance of RG 1.143, RG 1.54, "Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants," RG 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning," and IE Bulletin 80-10, "Contamination of Nonradioactive System and Resulting Potential for Unmonitored, Uncontrolled Release of Radioactivity to Environment."
7. Design and expected temperatures and pressures and materials of construction of components of the LWMS and provisions to protect temperature-sensitive filtration and adsorption media from thermal damage and resulting degradation in decontamination factors or removal efficiencies.
8. Design provisions to preclude placing components and SSCs under adverse vacuum conditions.
9. Provisions incorporated in equipment and facility design to reduce leakage and facilitate operation and maintenance using the guidelines of RG 1.143 for liquids and liquid wastes produced during normal operation and AOOs.
10. Design features that would reduce volumes of liquid wastes processed by the LWMS; reduce radioactivity levels and discharges of radioactive materials in liquid effluents; minimize, to the extent practicable, contamination of the facility and environment; facilitate eventual decommissioning; and minimize, to the extent practicable, the generation of radioactive waste using the guidelines of RG 4.21 and NUREG/CR-3587, "Identification and Evaluation of Facility Techniques for Decommissioning of Light Water Reactors."
11. Special design features to reduce leakage of liquid waste or discharges of radioactive materials to avoid uncontrolled and unmonitored releases to the environment using the guidance in IE Bulletin 80-10 and RG 4.21.

12. Design features used to collect and vent radioactive gases and vapors from tanks, vessels, and processing equipment to the appropriate radioactive exhaust ventilation and filtration subsystems using the guidance of SRP Section 9.4; SRP Section 11.3, "Gaseous Waste Management System"; and SRP Section 11.5, "Process and Effluent Radiological Monitoring Instrumentation and Sampling Systems"; 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"; and RG 1.143.
13. Design features of containment systems, such as steel liners and concrete enclosures, used in equipment rooms and cubicles where tanks are located that would be capable of containing the entire expected inventory of one or more tanks in the event of spills, leaks, and component failures.
14. Design features describing automatic control features, and justification for the placement of isolation valves and radiation detectors on process piping and effluent discharge lines to ensure the timely closure of such valves upon the detection of elevated radioactivity levels. If part of the design, description of controls in monitoring deviations of in-plant dilution flow rates and features to terminate releases or isolating process flows when deviations exceed preset limits.
15. Special design features, topical reports incorporated by reference, and data obtained from previous experience with similar systems as described in the SAR or other supporting documents (e.g., the design basis documentation from other operating plants).
16. For multi-unit reactor stations, descriptions and design features of equipment and components (included in permanently installed systems or in combination with mobile processing equipment) normally shared between interconnected processing and treatment subsystems.
17. Types and characteristics of filtration, ion-exchange resins, and adsorbent media to treat liquid process and effluent streams, including expected removal efficiencies, decontamination factors, holdup or decay times, and the applications of these characteristics in estimating releases by specific waste streams and treatment methods. The information describing the types of proposed filtration and adsorption media should include details from the applicant or suppliers, as generic or plant-specific information, in characterizing removal efficiencies, decontamination factors, and holdup or decay times.
18. Design features and operational safeguards to prevent the introduction and mixing of chemical additives with ion-exchange resins in avoiding the generation of exothermic reactions and explosive gas mixtures (e.g., hydrogen and methane) in LWMS and solid waste management system components.
19. Definition of the boundary of the LWMS beginning at the interface from plant systems provided for the collection of process streams and radioactive liquid wastes to the point of controlled discharges to the environment as defined in the Offsite Dose Calculation Manual (ODCM), or at the point of recycling to the primary or secondary water system storage tanks using the guidance of RG 1.143 for liquid wastes and liquid effluents produced during normal operation and AOOs.

20. For plant designs with impoundment facilities and cooling ponds/canals through which LWMS radioactive effluents are discharged to unrestricted areas, descriptions of design features credited in meeting the requirements of 10 CFR 20.1406 and guidance of RG 4.21 in minimizing the contamination of plant discharge blowdown systems and the environment, including groundwater and surface water.
21. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For DC and COL reviews, the staff reviews the applicant's proposed ITAAC associated with the SSCs related to this SRP section using SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate using the applicable portions of SRP Section 14.3 and RG 1.215, "Guidance for ITAAC Closure under 10 CFR Part 52."
22. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will address COL action items and requirements and restrictions (e.g., interface requirements and site parameters), and note instances where an applicant has submitted conceptual design information for portions of the plant for which the application does not seek certification, given the requirements of 10 CFR 52.47(a)(24) to 52.47(a)(26), 10 CFR 52.79(d)(2), and 10 CFR 52.80(a).
23. COL application referencing a DC. 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 FSAR Tier 1, Tier 2, and Tier 2\* information. Additionally, a COL applicant must address requirements and restrictions (e.g., system interfaces and site parameters) included in the referenced DC and how they are being addressed under plant- and site-specific conditions.
24. 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 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 using the guidance 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, and conditions stipulated in the ESP, including COL action items. The staff should consider the following potential exposure pathways based on site-specific or regional land-use information: ingestion of aquatic food; ingestion of drinking water (ground and surface water); use of water in food processing or as an ingredient; crop and pasture irrigation; livestock watering; ingestion of animal and agricultural products subjected to watering or irrigation; exposure to shoreline sediment, and exposure to water through boating and swimming activities.

## Review Interfaces

The staff should use the following SRP section interfaces as the basis for reviewing supplemental or complementary information provided in the FSAR for a specific plant design. The reviewer of this SRP section should verify specific information, as needed to complete the evaluation, and coordinate this review with that of primary reviewers of the sections listed below. Other SRP sections that interface with this section are as follows:

1. The review of the design provisions of the LWMS incorporated to control, sample, and monitor radioactive materials in liquid process and effluent streams is performed using the guidance in SRP Section 11.5.
2. The reviews of compliance with certified standard designs and ESPs, COL information items, and conformance with regulatory guidance (RG, SECY, Regulatory Issue Summary (RIS), bulletins, notices, and generic letters) are performed under SRP Chapter 1, "Introduction and Interfaces," Items 1.8 and 1.9.
3. The review of the exclusion area boundary and administrative controls in managing liquid effluent releases is performed using the guidance in SRP Sections 2.1.2, "Exclusion Area Authority and Control," and 11.5, "Process and Effluent Radiological Monitoring Instrumentation and Sampling Systems."
4. The review of the impacts of an accidental release of radioactive liquids in groundwater or surface water and effects on existing users or likely future users of groundwater or surface water resources is performed using the guidance in SRP Sections 2.4.1, "Hydrologic Description"; 2.4.12, "Groundwater"; and 2.4.13, "Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters"; and information and guidance from Branch Technical Position (BTP) 11-6, "Postulated Radioactive Releases Due to Liquid-containing Tank Failures"; as referenced herein.
5. The review of independent source term calculations for the purpose of assessing the performance of the LWMS against NRC requirements of 10 CFR 20.1301 and 10 CFR 20.1302; Table 2, Column 2 and Note 4 of Appendix B to 10 CFR Part 20; and design objectives and ALARA provisions of Appendix I to 10 CFR Part 50, is performed under SRP Section 11.1, "Coolant Source Terms," using the guidance in RG 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," NUREG-0016, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors (BWRs)," or NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWRs)," and American National Standards Institute/American Nuclear Society (ANSI/ANS) 18.1-1999, as modified to reflect specific design features.
6. The review of dose calculation methods and parameters of the standard radiological effluent controls (SREC), as they relate to the development of the ODCM, is performed using the guidance in SRP Sections 11.5, "Process and Effluent Radiological Monitoring Instrumentation and Sampling Systems," and 13.4, "Operational Programs," and sections on operating and administrative procedures in SRP section from SRP Chapter. 13 "Conduct of Operations" (13.5 subsections).

7. The review of the acceptability of the design analyses, procedures, and criteria used to establish the ability of Seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena, such as the safe-shutdown earthquake, the probable maximum flood, and tornadoes and tornado missiles is performed using the guidance in SRP Sections 3.3.1, "Wind Loadings"; 3.3.2, "Tornado Loadings"; 3.4.2, "Analysis Procedures"; 3.5.3, "Barrier Design Procedures"; 3.7.1, "Seismic Design Parameters"; through 3.7.4, "Seismic Instrumentation"; 3.8.4, "Other Seismic Category I Structures"; 3.8.5, "Foundations"; and in RG 1.143 with respect to natural phenomena and man-induced hazards used in assigning safety classifications to SSCs for the LWMS.
8. The review of the acceptability of the seismic and quality group classifications for system and components is performed using the guidance in SRP Sections 3.2.1, "Seismic Classification," and 3.2.2, "System Quality Group Classification."
9. The review of radiation monitoring instrumentation and controls used by the LWMS, including provisions for automatic control features and interdependence with sensing elements other than radioactivity (e.g., fluid level, valve position, system pressure, flow rate, and temperature), is performed using the guidance presented in SRP Sections 11.5 and 9.3.2, "Process and Post-accident Sampling Systems." The review addresses the types and placement of such sensors in plant subsystems, basis of operational ranges, and qualification of sensing elements in supporting the functions of radiation monitoring subsystems. The review considers functional interdependence and logic in alarming, terminating, and/or diverting process or effluent streams to comply with the dose and effluent concentration limits under 10 CFR Part 20 and design objectives of Appendix I to 10 CFR Part 50. The review also addresses design features to prevent radioactive contamination of otherwise nonradioactive plant systems in avoiding unmonitored and uncontrolled releases of radioactive materials in the environment using the guidance of RGs 1.143, 4.21, and IE Bulletin 80-10.
10. The review of the demineralized water makeup system is performed using the guidance in SRP Section 9.2.3, "Demineralized Water Makeup System," as it relates to the supply of seal water to systems and components containing radioactivity and design features to prevent the contamination of nonradioactive systems and avoid unmonitored and uncontrolled releases to the environment.
11. The review of the Chemical and Volume Control System (CVCS) (including Boron Recovery System) is performed using the guidance in SRP Section 9.3.4, as it relates to systems and components containing radioactivity and design features to process CVCS fluid streams prior to recycling or treatment before releasing to the environment.
12. The review of process fluids collected by equipment and floor drains is performed using the guidance in SRP Sections 5.2.5, "Reactor Coolant Pressure Boundary Leakage Detection"; 5.4.8, "Reactor Water Cleanup System (BWR)"; 5.4.13, "Isolation Condenser System (BWR)"; 9.1.2, "New and Spent Fuel Storage"; 9.1.3, "Spent Fuel Pool Cooling and Cleanup System"; 9.2.4, "Potable and Sanitary Water Systems"; 9.2.6, "Condensate Storage Facilities"; 9.3.2, 9.3.3, "Equipment and Floor Drainage System"; 9.3.4, and 10.4.8, "Steam Generator Blowdown System (PWR)"; and BTP 5-1 in monitoring secondary side water chemistry in PWR steam generators.

13. With respect to the operation of the LWMS and associated releases of liquid effluents to unrestricted areas regulated under 10 CFR Part 20, the review of instrumentation and components, with respect to capability, reliability, and conformance to the acceptable criteria are reviewed using the guidance in SRP Sections 7.1, "Instrumentation and Controls – Introduction"; 7.5, "Information Systems Important to Safety"; 7.6, "Interlock Systems Important to Safety"; and 7.7, "Control Systems" and related branch technical positions in SRP Chapter 7, as mandated by design and operational considerations.
14. The review of primary and secondary coolant systems as they relate to features provided to limit or reduce the buildup of radioactivity in tanks, heat exchangers, steam generators, and other components is performed using the guidance in SRP Sections 5.2, 5.4, "Reactor Coolant System Component and Subsystem Design"; 12.3-12.4, "Radiation Protection Design Features"; 11.5; and BTP 5-1 as they relate to the sensitivity of installed radioactivity detectors and operational methods described in Nuclear Energy Institute (NEI) 97-06 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML111310712) and applicable Electric Power Research Institute guidelines described in SRP Section 12.3-12.4.
15. The review of processing systems to treat regenerant solutions from the condensate cleanup system is performed using the guidance in SRP Section 10.4.6.
16. The review of the liquid effluent discharge path to the circulating water system and plant blowdown to unrestricted areas, as they relate to site-specific balance of plant design features, is performed using the guidance in SRP Section 10.4.
17. The review of applicable technical specifications (TS) is performed using the guidance in SRP Sections 11.5 and 16.0. Under SRP Section 16, the TS address the elements of administrative programs on radioactive effluent controls and monitoring. The associated guidance is presented in standard technical specifications, including NUREG-1430, NUREG-1431, NUREG-1432, NUREG-1433, and NUREG-1434.
18. The review of the QA program is performed using the guidance in SRP Chapter 17 for any portion of the LWMS that may be covered by 10 CFR Part 50, Appendix B requirements, depending on design features. The guidance of RG 1.143 applies to the balance of LWMS since it is not a safety related system.
19. The review of the LWMS fire protection program for storage of inflammable and combustible radioactive wastes (e.g., sludge, spent resins, and activated charcoals) is performed using the guidance in SRP Sections 9.5.1.1, "Fire Protection Program," and 11.4, "Solid Waste Management System," using the guidance in RG 1.189, "Fire Protection for Nuclear Power Plants," and RG 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants," as they relate to the conduct of fire hazards analysis involving the presence of radioactivity in combustible or flammable materials and compliance with 10 CFR Part 20 in assessing radiological impacts to workers and members of the public if exposed to combustion products.
20. For any portion of the LWMS post-accident subsystems that supports safety-related functions, as identified by the applicant, the review of these design features is performed using the guidance SRP Chapter 7 and SRP Section 13.3, "Emergency Planning." In this context, the review, using the guidance in RG 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants," and BTP 7-10, "Guidance on Application of

Regulatory Guide 1.97,” addresses the performance, design, qualification, display, quality assurance, and selection of monitoring variables of radiation monitoring equipment required for accident monitoring and sampling.

21. The review of design features of building exhaust and ventilation systems servicing radiologically controlled areas where LWMS equipment and radioactive materials are located and used to vent tanks and process equipment (e.g., via the use of high efficiency particulate air filters (HEPA) and activated charcoal filters) is performed using the guidance in SRP Sections 9.4 and 11.3. SRP Section 11.5 provides guidance on the review of instrumentation used to monitor and control (terminate and/or divert) gaseous radioactive effluent releases and process streams associated with ventilation systems.
22. The review of design features for the protection of potable and sanitary water systems is performed using the guidance of SRP Sections 9.2.4 and 11.5, as they relate to system interfaces in avoiding potential bypass routes to nonradioactive systems and radiological monitoring.
23. The review of design features of the LWMS attributed for compliance with 10 CFR 20.1406 is performed using the guidance in SRP Section 12.3-12.4, using the guidance of RG 4.21.
24. The review of design features with the means to return samples collected from process and effluent streams to their origins and prevent sampled streams from being discharged locally or released to the environment without being monitored is conducted using the guidance in SRP Section 11.5.
25. The review of design features to purge and flush sampling lines and monitors with nonradioactive fluids (e.g., clean water, air, inert gases) and route purged or flushed fluids to the most appropriate systems (LWMS and gaseous waste management system (GWMS)) is conducted using the guidance in SRP Section 11.5. The review should confirm that the source of nonradioactive purging or flushing fluids is protected from backflow and cross-contamination using appropriate measures, such as check valves, backflow preventers, interlocks, differential pressures, etc.
26. The review of design features of the LWMS credited for radiation protection of plant workers and compliance with 10 CFR Part 20 and guidance of RG 8.8, “Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable,” and RG 8.10, “Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable,” is performed using the guidance in SRP Chapter 12.
27. The review of design features of LWMS subsystems and components associated with the plant’s initial testing plan, description of tests, and testing acceptance criteria is performed in SRP Sections 11.5 using the guidance in RG 1.68, “Initial Test Programs for Water-Cooled Nuclear Power Plants,” and RG 14.2, “Preparation of Environmental Reports for Nuclear Power Stations,” with information drawn from SRP Sections 5.2, 5.4, 9.1, 9.2, 9.3, 9.4 and 10.4.
28. The completeness of the description of the LWMS design and its operational features is reviewed using the guidance in SRP Section 14.3.7, “Plant Systems - Inspections, Tests, Analyses, and Acceptance Criteria,” to ensure that there is sufficient information in

FSAR Tier 1 in confirming that ITAAC are inspectable and compliance can be demonstrated with no ambiguity.

## II. ACCEPTANCE CRITERIA

### Requirements

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

1. 10 CFR 20.1101(b), as it relates to the use of procedures and engineering controls in maintaining doses to members of the public ALARA.
2. 10 CFR 20.1301, 10 CFR 20.1302, and Table 2, Column 2 and Note 4 of Appendix B to 10 CFR Part 20, as they relate to radioactivity in liquid effluents released to unrestricted areas and doses to offsite receptors located in unrestricted areas.
3. 10 CFR 20.1406, as it relates to the design and operational procedures to minimize contamination, facilitate eventual decommissioning, and minimize the generation of radioactive waste.
4. 10 CFR 50.34, as it relates to the kinds and quantities of radioactive materials produced during operations and the means to control and limit radioactive effluent releases and radiation exposures within the limits of 10 CFR 20.1301 and 20.1302 for members of the public.
5. 10 CFR 50.34(f), as it relates to additional Three Mile Island (TMI)-related requirements and TMI Action Plan Items and Generic Safety Issues (GSIs) identified in NUREG-0933, "Resolution of Generic Safety Issues (Formerly entitled "A Prioritization of Generic Safety Issues")."
6. 10 CFR 50.34a, as it relates to the availability of sufficient design information to demonstrate that design objectives for equipment necessary to control releases of radioactive effluents to the environment have been met.
7. 10 CFR 50.36a(b), as it relates to experience with the design, construction, and operations of nuclear power reactors in complying with 10 CFR 20.1301 and in maintaining doses to members of the public ALARA.  
  
10 CFR 50.59, "Changes, Tests, and Experiments," implemented using the guidance in RG 1.187, "Guidance for Implementation of 10 CFR 50.59, Changes, Tests, and Experiments," as it relates to design changes and differences in treatment performance characteristics of LWMS components in demonstrating compliance with effluent concentration limits of 10 CFR Part 20, Appendix B, Table 2.
8. 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2, as it relates to the design bases of structures housing LWMS and its components using the guidance of RG 1.143 in assigning seismic, safety, and quality group classifications for natural phenomena and man-induced hazards as defined in RG 1.143 in assigning safety classifications to LWMS SSCs for design purposes.

9. 10 CFR Part 50, Appendix A, GDC 3, as it relates to the design of LWMS subsystems and operational safeguards to avoid the generation of explosive gas mixtures and exothermic reactions through the inadvertent introduction and mixing of chemical agents with ion exchange resins using the guidance in RGs 1.189 and 1.205, as they relate to the conduct of fire hazards analysis involving the presence of radioactivity in combustible or flammable materials.
10. 10 CFR Part 50, Appendix A, GDC 60, as it relates to the ability of the LWMS design to control releases of radioactive materials to the environment.
11. 10 CFR Part 50, Appendix A, GDC 61, as it relates to the ability of the LWMS design to ensure adequate safety under normal and postulated accident conditions, as provided in SRP Sections 2.4.13 and 11.2, "Liquid Waste Management System," using the guidance in BTP 11-6 and the analysis of RG 1.143 in assigning the safety classifications to LWMS SSCs for design purposes.
12. 10 CFR Part 50, Appendix B, as it applies to LWMS subsystems and components not covered by the QA guidance of RG 1.143.
13. 10 CFR Part 50, Appendix I, Sections II.A and II.D, as they relate to the numerical guidelines for design objectives and limiting conditions for operation to meet the "as low as is reasonably achievable" ALARA criterion.
14. 40 CFR Part 190 (the U.S. Environmental Protection Agency's (EPA) generally applicable environmental radiation standards), as implemented under 10 CFR 20.1301(e), as it relates to limits on annual doses from all sources of radioactivity contained in liquid effluents and external radiation from site buildings and facilities (with single or multiple reactor units). SRP Sections 11.3 and 11.4 evaluate source terms and doses from gaseous effluents and solid wastes. In turn, SRP Section 11.5 addresses the means to demonstrate compliance with all sources of effluents. SRP Section 12.3-12.4 evaluates doses associated with external radiation from buildings and contained sources of radioactivity in systems and components.
15. 10 CFR 52.17(a)(1)(ii), which requires that an ESP application include the anticipated levels of radioactive effluents released in plant environs and provide 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.
16. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria are met, a plant that incorporates the DC is built and will operate in accordance with the DC, the provisions of the Atomic Energy Act (AEA), and the NRC regulations. For the LWMS, ITAAC should be assigned to systems and components that are used to comply with 10 CFR Part 20. Such systems and components may include radiation monitoring equipment and valves that would terminate or divert a release upon detecting elevated levels of radioactivity or departures in plant dilution and discharge flow rates from which alarm set points are derived for radiation monitoring instrumentation.
17. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that

the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria are met, the facility has been constructed and will operate in conformity with the COL, the provisions of the AEA, and the NRC regulations.

### SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC regulations identified above are set forth below. 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 this SRP section 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 of complying with the regulations that underlie SRP acceptance criteria and meeting 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.

1. The LWMS should have the capability to meet the design objectives of 10 CFR Part 50, Appendix I and include provisions to treat liquid radioactive wastes such that the following is true:
  - A. The calculated annual total quantity of all radioactive materials released from each reactor at the site to unrestricted areas will not result in an estimated annual dose or dose commitment from liquid effluents for any individual in an unrestricted area from all pathways of exposure in excess of 0.03 millisievert (mSv) (3 millirem (mrem)) to the total body or 0.1 mSv (10 mrem) to any organ under 10 CFR Part 50, Appendix I, Section II.A. RG 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," RG 1.112, RG 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," and the LADTAP II computer code (NUREG/CR-4013) that provide acceptable methods for performing this analysis.
  - B. In addition to 1.A, the LWMS should include all items of reasonably demonstrated technology that, when added to the system sequentially and in order of diminishing cost-benefit return for a favorable cost-benefit ratio, can effect reductions in doses to the population reasonably expected to be within 80 kilometers (km) (50 miles (mi)) of the reactor and comply with the cost-benefit ratio of Section II.D of Appendix I. RG 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light Water Cooled Nuclear Power Reactors," provides an acceptable method for performing this analysis.
  - C. The concentrations of radioactive materials in liquid effluents released to unrestricted areas should not exceed the concentration limits in Table 2, Column 2, and Note 4 of Appendix B to 10 CFR Part 20.
2. The LWMS should be designed with adequate capacity to process liquid wastes during periods when major processing equipment may be down for maintenance (single failures) and during periods of excessive waste generation. Systems that have adequate capacity to process the anticipated wastes and that are capable of operating

within the design objectives during normal operation, including AOOs, are acceptable. To meet these processing demands, interconnections between subsystems, redundant equipment, mobile equipment, and reserve storage and treatment capacity will be considered.

3. The seismic design of structures housing LWMS components, the safety and quality group classifications of liquid radwaste treatment equipment, and provisions to prevent and collect spills from indoor and outdoor storage tanks should conform to the guidelines of RG 1.143 for liquids and liquid wastes produced during normal operation and AOOs. RG 1.143 provides guidance in assigning safety classifications to structures and radioactive waste management systems in protecting SSCs against natural phenomena and man-induced hazards. In addressing the regulatory positions of RG 1.143 on safety classifications of radwaste SSCs against unmitigated releases of radioactive materials or unmitigated radiation exposures to site personnel, the acceptance criteria are 1 mSv (100 mrem) for members of the public assumed to be located at or beyond the restricted area or in unrestricted areas (whichever is most limiting), and 5 rem (50 mSv) for a plant worker assumed to be located in the restricted area. In classifying system components, the radioactive inventories of components are compared to the criteria in determining the appropriate safety classification. RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," Part I, C.I.3, Sections 3.2.1 and 3.2.2 and SRP Section 3.8.4 identify applicable acceptance criteria in evaluating SSCs requiring seismic design considerations and discuss differences from the recommendations of RG 1.143.

The LWMS should be designed to meet the requirements of 10 CFR 20.1406. System designs should contain provisions to control leakage and facilitate operation and maintenance in accordance with the guidelines of RGs 1.33, "Quality Assurance Program Requirements (Operation)," 1.143 and 4.21 and industry standards (e.g., NEI 08-08A (ADAMS Accession No ML093220530)) cited in the guidance for liquids and liquid wastes produced during normal operation and AOOs. System designs should describe features that will minimize, to the extent practicable contamination of the facility and environment; facilitate eventual decommissioning; and minimize, to the extent practicable, the generation of radioactive waste, in accordance with the guidelines of Interim Staff Guidance (ISG) DC/COL-ISG-06, "Final Interim Staff Guidance Evaluation and Acceptance Criteria for 10 CFR 20.1406 to Support Design Certification and Combined License Applications," RG 4.21, and NEI 08-08A for liquids and liquid wastes produced during normal operation and AOOs.

For plant designs with impoundment facilities and cooling ponds/canals through which LWMS radioactive effluents are discharged to unrestricted areas, description should address how engineered design features and leakage detection monitoring methods satisfying the regulatory requirements of specific Federal and state agencies also demonstrate compliance with 10 CFR 20.1406 and guidance of RG 4.21 in minimizing the contamination of plant discharge blowdown systems and the environment, including groundwater and surface water. The description should present a summary of design features that would prevent leakage and seepage out of impoundment facilities and cooling ponds/canals (e.g., design features of liners), and monitoring methods applied to detect leakage and seepage in underlying soils and aquifers (e.g., types, locations, and number of monitoring wells).

4. For processing subsystems equipped with automatic control features, the application should provide the justification for the placement of isolation dampers/valves and

radiation detectors on process piping and effluent discharge lines to ensure the timely closure of such valves upon the detection of elevated radioactivity levels, and, if part of the design, controls in monitoring deviations of in-plant dilution flow rates and terminating releases or isolating process flows when deviations exceed preset limits. Other considerations may include determining whether system logic demands that a valve or damper should fail in the closed position in protecting the system from further contamination, terminating releases to the environment, or diverting process streams or effluents to appropriate treatment subsystems. Acceptable guidance is presented in SRP Section 11.5 and ANS N42.18-2004.

5. The design of exhaust ventilation subsystems used to collect and vent radioactive gases and vapors from tanks, vessels, and processing equipment should use the guidance of SRP Sections 9.4, 11.3, and 11.5, RGs 1.140 and 1.143, and industry standards. The guidance addresses the design, testing, maintenance, and monitoring of HEPA filters and charcoal absorbers installed in ventilation exhaust systems.
6. For an ESP application, the dose estimates to a hypothetical maximally exposed member of the public from liquid effluents using radiological exposure models are developed based on RGs 1.109, 1.112, and 1.113, and appropriate computer codes, such as the LADTAP II computer code (NUREG/CR-4013) for liquid effluents.

The relevant guidance (RG, ISG, and BTP) is as follows:

1. RG 1.109, as it relates to the use of acceptable methods for calculating annual doses to the maximally exposed individual in demonstrating compliance with 10 CFR Part 50, Appendix I dose objectives and ALARA provisions.
2. RG 1.110, as it relates to performing a cost-benefit analysis for reducing cumulative dose to the population by using available technology.
3. RG 1.112, as it relates to the use of acceptable methods for calculating annual average releases of radioactive materials in liquid effluents.
4. RG 1.113, as it relates to the use of acceptable methods for estimating aquatic dispersion and transport of liquid effluents in demonstrating compliance with 10 CFR Part 50, Appendix I dose objectives.
5. RG 1.143, as it relates to QA provisions for radioactive waste management systems, structures and components including LWMS subsystems and components not covered by the QA requirements of Appendix B to 10 CFR Part 50.
6. RG 1.143, as it relates to the seismic design, safety, and quality group classifications of components used in the LWMS and structures housing the systems and the provisions used to control the leakage of liquids and liquid wastes produced during normal operation, AOOs, and natural phenomena and man-induced hazards listed in RG 1.143.
7. RG 1.143, as it relates to the definition of the boundary of the LWMS beginning at the interface from plant systems to the point of controlled discharge to the environment, as defined in the ODCM for liquid effluents, or at the point of recycling to the primary or secondary water system storage tanks for liquids and liquid wastes produced during normal operation and AOOs.

8. DC/COL-ISG-05, "Interim Staff Guidance on the use of the 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," NUREG-0016 and NUREG-0017, as they relate to the use of the Gaseous and Liquid Effluents (GALE)86 Code in calculating routine radioactive releases in gaseous and liquid effluents from BWR and PWR plants.
9. DC/COL-ISG-06, NEI 08-08A, and RG 4.21, as they relate to acceptable levels of detail, content, and guidance in demonstrating compliance with 10 CFR 20.1406.
10. DC/COL-ISG-013, "Assessing the Radiological Consequences of Accidental Releases of Radioactive Materials from Liquid Waste Tanks for Combined License Applications," as it relates to guidance on reviewing the analysis of the radiological consequences of accidental releases of radioactive materials to groundwater and surface water.
11. BTP 11-6, as it relates to the assessment of a potential release of radioactive liquids following the postulated failure of a tank and its components, located outside of containment, and impacts of the release of radioactive materials into the nearest existing (or known future) water supply (surface or groundwater) when (1) used as a source of water for direct human consumption; or (2) used indirectly through livestock watering or irrigation of grazing pastures, consumption of animal products (meat and milk products), fish and invertebrate consumption, crop irrigation and consumption of such crops, or used as an ingredient in food products or food processing.
12. NUREG-1430, as it relates to Standard Technical Specifications — Babcock and Wilcox Plants.
13. NUREG-1431, as it relates to Standard Technical Specifications — Westinghouse Plants.
14. NUREG-1432, as it relates to Standard Technical Specifications — Combustion Engineering Plants.
15. NUREG-1433, as it relates to Standard Technical Specifications — General Electric Plants (BWR/4).
16. NUREG-1434, as it relates to Standard Technical Specifications — General Electric Plants (BWR/6).

#### Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this SRP section is discussed in the following paragraphs:

1. 10 CFR 20.1302 requires that surveys of radiation levels in unrestricted areas and radioactive materials in effluents released to unrestricted areas be performed to demonstrate system compliance with the dose limits to individual members of the public, as specified in 10 CFR 20.1301 and 10 CFR 20.1301(e).

10 CFR 20.1302 identifies two approaches, either of which can demonstrate compliance with the dose limits of 10 CFR 20.1301 and 10 CFR 20.1301(e). The requirements for each one of these approaches are as follows:

- A. Demonstrate that the annual average concentrations of radioactive materials released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the effluent concentration limits specified in Table 2, Column 2, and Note 4 of Appendix B to 10 CFR Part 20.
- B. Demonstrate that the annual and hourly doses from external sources to an individual continuously present in an unrestricted area will not exceed 0.5 mSv (0.05 rem) and 0.02 mSv (0.002 rem), respectively.

Meeting the above requirements provides reasonable assurance that the dose limits to individual members of the public specified in 10 CFR 20.1301 and 10 CFR 20.1301(e) will not be exceeded. Meeting the dose requirements identified above will be evaluated as part of the review described in this SRP section. Meeting the requirements on gaseous effluents generated as a byproduct of the operation of the LWMS and concentration limits in unrestricted areas is identified as an acceptance criterion in SRP Section 11.3 and guidance for performing that review is in that SRP section as well.

- 2. 10 CFR 20.1406 requires that applicants describe how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment; facilitate eventual decommissioning; and minimize, to the extent practicable, the generation of radioactive waste. DC/COL-ISG-06, NEI 08-08A, and RG 4.21 provide guidance for use in implementation of the requirements of 10 CFR 20.1406. Specific guidance to meet 10 CFR 20.1406 is identified in RG 4.21, Regulatory Positions C.1 through C.4. DC/COL-ISG-06 is incorporated in SRP Section 12.3-2.4.
- 3. Meeting the requirements of 10 CFR 50.34a, as they relate to the LWMS, provides assurance that each nuclear power reactor will meet the criterion that controlled releases of radioactive materials in effluents to unrestricted areas in its vicinity will be kept ALARA and that the LWMS will have the necessary design features and equipment to control releases of radioactive liquid effluents to the environment in accordance with the requirements of 10 CFR 20.1301 and 20.1302, Appendix I to 10 CFR Part 50, and GDC 60 and 61. See separate discussion below, on the requirements of 10 CFR Part 20.1301(e).
- 4. Appendix I to 10 CFR Part 50 provides numerical guides on design objectives to meet the requirements that radiation doses caused by radioactive materials in effluents released to unrestricted areas be kept ALARA. Sections II.A and II.D of Appendix I relate to the numerical guides for dose design objectives, limiting conditions for operation, and controls to meet the ALARA criterion for liquid effluents.

RGs 1.109 and 1.113 provide acceptable methods for performing dose analyses to demonstrate that the LWMS design and its operation result in doses, due to releases of radioactive materials from each reactor, that comply with 10 CFR Part 50, Appendix I design objectives.

RG 1.110 provides an acceptable method of performing cost-benefit analysis to demonstrate that the LWMS design includes all items of reasonably demonstrated technology for reducing cumulative population doses from releases of radioactive materials from each reactor to ALARA levels within an 80 km (50 mi) radius of the reactor and to comply with the cost-benefit ratio of Section II.D of Appendix I.

Meeting the requirements of Section II.A of Appendix I to 10 CFR Part 50 provides assurance that the limits for radiation doses to a maximally exposed offsite individual from liquid effluents and ALARA provisions of Section II.D of Appendix I will be met.

5. Compliance with GDC 60 requires that each nuclear power plant design shall include means to control releases of radioactive materials in liquid effluents and to handle radioactive wastes (e.g., solid, sludge, resins, etc.) produced during normal reactor operation, including AOOs.

GDC 60 requires that waste management systems provide for a holdup capacity sufficient to retain the radioactive waste, particularly where unfavorable site environmental conditions may impose unusual operational limitations upon the release of effluents. The holdup capacity should provide sufficient decay time for shorter-lived radionuclides before they are processed further or released to the environment. The holdup times are used in the source term calculations based on the methods described in RG 1.112, NUREG-0016 (BWRs), NUREG-0017 (PWRs), or ANSI/ANS 18.1-1999, as modified to reflect specific design features.

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 each 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, and radiological properties of liquid process and effluent streams, and processing flow rates. The review should determine whether performance meets that noted in NRC guidance contained in NUREG-0016 or NUREG-0017 (as modified using the guidance of SRP Section 11.1 and DC/COL-ISG-05), standard DCs, industry standards, and/or topical reports and industry data for new or alternate liquid waste treatment methods, e.g., centrifugal separation, evaporation, ultra-filtration, reverse osmosis, etc.

Meeting the requirements of GDC 60 provides assurance that releases of radioactive materials in liquid effluents to unrestricted areas during normal operation of the plant and during AOOs will not result in offsite radiation doses in excess of the dose objectives specified in Appendix I to 10 CFR Part 50 and that concentrations of radioactive materials in liquid effluents in any unrestricted area will not exceed the limits specified in Table 2, Column 2 and Note 4 of Appendix B to 10 CFR Part 20.

The control of radioactive gases and vapors, generated as a byproduct of the operation of the LWMS, is addressed through the design considerations of exhaust ventilation and treatment subsystems under the guidelines of SRP Sections 9.4, 11.3, and 11.5, RGs 1.140 and 1.143, and industry standards. The guidance addresses the design, testing, and maintenance of HEPA filters and charcoal absorbers installed in exhaust ventilation systems servicing radioactive systems and radiologically controlled plant areas where LWMS components are located. The guidelines also address radiation

monitoring systems and provisions to sample and analyze process flows and gaseous effluent releases.

6. Compliance with GDC 61 requires that the LWMS and other systems (as permanently installed systems or in combination with mobile systems) that may contain radioactivity shall be designed to ensure adequate safety under normal and postulated accident conditions. This criterion specifies that such facilities shall be designed with a capability to permit inspection and testing of components important to safety and with suitable shielding for radiation protection.

RG 1.143 describes design guidance acceptable to the NRC staff related to seismic, safety, and quality group classifications and QA provisions for SSCs associated with the LWMS and process streams and liquid wastes produced during normal operation and AOOs. RG 1.143 provides guidance in assigning safety classifications to structures and radioactive waste management systems in protecting SSCs against natural phenomena and man-induced hazards. For unmitigated releases of radioactive materials, the acceptance criterion of RG 1.143 is 1 mSv (100 mrem) for members of the public assumed to be located at or beyond the restricted area or in unrestricted areas (whichever is most limiting). For unmitigated radiation exposures to site personnel, the acceptance criterion is 5 rem (50 mSv) for a plant worker assumed to be located in the restricted area. In classifying system components, the radioactivity inventories of components are compared to the acceptance criteria in determining the appropriate safety classification. In addition, RG 1.206, Part I, C.I.3, Sections 3.2.1 and 3.2.2 and SRP Section 3.8.4 identify applicable acceptance criteria in evaluating SSCs requiring seismic design considerations and discuss differences from the recommendations of RG 1.143.

Meeting the requirements of GDC 61 provides assurance that releases of radioactive materials during normal operation and AOOs, including adverse vacuum conditions on system components, will not result in radioactive material concentrations and radiation exposures that exceed dose and concentration limits specified in 10 CFR Part 20. In addition, meeting this requirement will help ensure that the LWMS will continue to perform its functions under postulated accident conditions.

Using the guidance of RG 1.143 provides reasonable assurance that the assigned safety classifications for structures housing the LWMS and its components comply with the requirements of GDC 2 and 61 and the guidance of RG 1.143 for natural phenomena and man-induced hazards. Using the guidance of SRP Section 2.4.13 and BTP 11-6 (as referenced herein), and using the analysis of RG 1.143 in assigning the safety classifications to SSCs of the LWMS for design purposes, provide reasonable assurance that the necessary information is available to identify the amounts of radioactive materials contained in the LWMS and assess the radiological impacts during postulated accidents.

7. Radioactive materials should be processed, handled, and stored using equipment, methods, and procedures that avoid or minimize potential releases of radioactivity in the event of a fire. GDC 3 relates to fire protection features for SSCs important to safety and can be used to provide guidance for LWMS design features and operational safeguards to prevent, for example, the generation of exothermic reactions and explosive gas mixtures through the introduction and mixing of chemical additives with ion-exchange resins.

Using GDC 3 to review systems important to safety provides assurance that the LWMS is protected from the effects of explosive gas mixtures and exothermic reactions and that the functions of its subsystems and components will not be compromised in meeting the effluent discharge concentration limits of 10 CFR Part 20 associated with releases of contaminated fire protection water and combustion gases and smoke. Specific NRC guidance is provided in RG 1.189, RG 1.205, and IE Information Notices 83-14, 84-72, 88-08, and 90-50, and in NUREG/CR-4601.

8. BTP 11-6 provides guidance and acceptance criteria on how to evaluate the consequences of the release of radioactive liquids following the postulated failure of a tank and its components, located outside of containment, and radiological consequences at the nearest water supply (surface water or groundwater), located in an unrestricted area, for direct human consumption or indirectly through animals, crops, and food processing. The analysis assumes that a tank and its components fail to meet design criteria as required by 10 CFR 50.34a, and GDC 60 and 61 of Appendix A to Part 50.

BTP 11-6 presents guidelines and a graded approach in assessing the radiological impacts of tank failures. SRP Sections 2.4.12 and 2.4.13 present information and guidance on modeling the transport of associated radioactivity in groundwater and surface water bodies. The guidance provides reasonable assurance that the radiological consequences of a single failure of a tank and its components would not exceed the acceptance criteria of BTP 11-6 in an unrestricted area, assuming direct or indirect water consumption by any member of the public. If the results of a plant- and site-specific analysis do not meet BTP 11-6 acceptance criteria, the applicant should propose TS limiting the total amount of radioactivity in such a tank and components, as described in SRP Chapter 16, Section 5.5, Programs and Manuals, as adopted from standard technical specifications (NUREG-1430, NUREG-1431, NUREG-1432, NUREG-1433, and NUREG-1434).

9. 10 CFR 20.1301(e) requires that NRC-licensed facilities comply with the EPA generally applicable environmental radiation standards of 40 CFR Part 190 for facilities that are part of the fuel cycle. The EPA annual dose limits are 0.25 mSv (25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid, and 0.25 mSv (25 mrem) to any other organ.

Meeting the requirements of 10 CFR 20.1301(e) requires the consideration of all potential sources of external radiation and radioactivity, including liquid and gaseous effluents and external radiation exposures from buildings, storage tanks, radioactive waste storage areas, and N-16 skyshine from BWR turbine buildings. The EPA standards apply to the entire site or facility, whether it has single or multiple reactor units. SRP Sections 11.3 and 11.4 address the sources of radioactivity and doses associated with gaseous effluents and solid wastes, respectively. SRP Section 12.3-12.4 addresses the sources of radiation and external radiation exposures from buildings, storage tanks, radioactive waste storage areas, and N-16 skyshine from BWR turbine buildings.

### III. REVIEW PROCEDURES

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 the proposed alternatives provide an acceptable method of complying with the relevant NRC

requirements and guidance identified in Subsection II. The review should confirm that the applicant has submitted sufficient information for the staff to conduct an independent evaluation of any proposed alternative method and demonstration of compliance with NRC regulations and SRP acceptance criteria and supporting regulatory guidance.

While the LWMS has been categorized as nonsafety-related and nonrisk-significant, the failure of specific subsystems or components may have impacts on the means to control and monitor liquid effluent releases and in complying with NRC regulations under 10 CFR Part 20 and 10 CFR Part 50, Appendix I. As such, the review of the LWMS must be sufficiently detailed to assess whether a failure of any LWMS subsystem may have an impact on demonstrating compliance with the requirements of 10 CFR Part 20, Appendix B, Table 2 Effluent Concentration Limits and dose limits to members of the public and design objectives and ALARA provisions of 10 CFR Part 50, Appendix I. The applicant's FSAR and failure analysis will be reviewed to confirm that sufficient information has been provided demonstrating that the failure of essential subsystems will not result in plant or operating conditions in noncompliance with NRC regulations on exposure to workers and members of the public and that the FSAR and failure analysis conform with SRP acceptance criteria.

The NRC staff will review the information describing the design features of the LWMS provided in the FSAR, to the extent not addressed in a referenced certified design, including referenced parts of SRP Sections 9.1, 9.2, 9.3, 10.4, 11.1, 11.2, 11.3, 11.4, 11.5, and 12.3-12.4, for completeness using the guidance of RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)," or RG 1.206. While the SRP references RGs 1.70 and 1.206, not all sections of RG 1.70 have a corresponding review plan section. The SRP sections applicable to a COL application for a new light-water reactor (LWR), submitted under 10 CFR Part 52, are based on RG 1.206.

1. Programmatic requirements. Commission regulations and policy mandate "programs" applicable to SSCs that include:
  - A. Technical Specifications, Section 5, Administrative Controls (as described standard technical specifications), as they relate to administrative programs on radioactive effluent controls and monitoring via the ODCM, SREC, and Radiological Environmental Monitoring Program (REMP). The associated TS are presented in NUREG-1430, NUREG-1431, NUREG-1432, NUREG-1433, and NUREG-1434. The review of the SREC, ODCM, and REMP may be conducted as part of the review of SRP Sections 11.4 or 11.5, depending on where the applicant has located the procedural details and programmatic controls, given the provisions of Generic Letter 89-01 and NUREG-1301 or NUREG-1302.
  - B. Startup initial testing plan, as described in SRP Section 14.2 using the guidance in RGs 1.68 and 1.33.
  - C. Implementation of these programs will be inspected in accordance with NRC Inspection Manual Chapter IMC-2504, "Construction Inspection Program – Non-ITAAC Inspections."
  - D. If applicable, the staff reviews the proposed augmentation of programmatic elements in assessing the adequacy of the LWMS design and resulting effects on the development of the radioactive liquid effluent source terms. The staff's evaluation and conclusion of the acceptability of the augmented programmatic

elements is addressed in Safety Evaluation Report (SER) Section 13.4, “Operational Programs,” and relevant requirements and guidance identified in this SER section for the subsystems and components identified in the supplemental or new programmatic elements.

2. For new reactor license applications submitted under 10 CFR Part 52, the applicant is required to (1) address the proposed technical resolution of unresolved safety issues and medium- and high-priority GSIs that are identified in the version of NUREG-0933 current on the date 6 months before the submission of the 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 the technically relevant portions of the TMI requirements set forth in 10 CFR 50.34(f), except paragraphs (f)(1)(xii), (f)(2)(ix), and (f)(3)(v), as referenced in 10 CFR 52.47(a)(21), 10 CFR 52.47(a)(22), and 10 CFR 52.47(a)(8), respectively. With respect to NUREG-0933, TMI Action Plan items, Task III.D (Radiation Protection) and Task III.D.2 (Public Radiation Protection Improvement), the applicant should describe design features of the LWMS that are used to control and reduce potential exposures to offsite populations following an accident. With respect to GSIs, the applicant should present an evaluation of the issues listed in NUREG-0933 and, depending upon their applicability to the design, present information that demonstrates the implementation of acceptance criteria. These cross-cutting review areas should be addressed by the reviewer for each technical subsection and relevant conclusions should be documented in the corresponding sections of the SER.
3. The P&IDs and system process flow diagrams are reviewed to evaluate all sources and volumes of liquid process and effluent streams; points of collection of liquid wastes; the flowpaths of liquids through the system, including potential bypasses; the treatment provided and expected decontamination factors or removal efficiencies for radionuclides and holdup or decay time; and points of release of liquid effluents to the environment. With respect to potential bypasses, the review considers improper connection to nonradioactive systems and the possibility of uncontrolled and unmonitored liquid releases.

This information is used to calculate the quantity of radioactive materials released annually in liquid effluents during normal operation, including AOOs, using parameters listed in the application, the BWR-GALE Code or PWR-GALE Code, and calculation techniques of NUREG-0016 or NUREG-0017 using the guidance in RG 1.112 and ANSI/ANS 18.1-1999, as modified to reflect specific design features. In such instances, the evaluation should confirm that the applicant has submitted sufficient information for the staff to conduct an independent evaluation of proposed modifications or alternative methods for estimating yearly releases of radioactive materials in liquid effluents, using the SRP acceptance criteria and supporting regulatory guides. The result of this calculation will be used to determine whether the proposed treatment system design meets acceptance criterion 1.C of Subsection II of this SRP section and relevant acceptance criteria of SRP Section 11.1, on the basis of the radioactive source terms.

Conformance with acceptance criterion 1.A, given in Subsection II of this SRP section, concerning exposures to the total body or critical organ of an individual in an unrestricted area will be determined based on dose and source term calculations performed by NRC staff using the guidance in NUREG-0016 or NUREG-0017, RGs 1.112 and 1.113, and NUREG/CR-4013 (LADTAP II Code).

Conformance with acceptance criterion 1.B, given in Subsection II of this SRP Section, concerning the cost-benefit analysis will be determined based on analyses performed by NRC staff, including population cumulative dose (person-Sv (person-rem)) calculations and cost-benefit analyses. In its review, the staff has considered the potential effectiveness of augmenting the proposed LWMS using items of reasonably demonstrated technology and should confirm that that further effluent treatment will not affect reductions in cumulative population doses reasonably expected within an 80 km (50 mile) radius of the reactor, nor is it necessary to augment the design of the system for compliance with the cost-benefit ratio of Section II.D of Appendix I. RG 1.110 describes methods for performing such cost-benefit analyses.

4. The review of the LWMS design capacity will encompass the following major areas:
  - A. The system capability to process waste volume inventories in the event of a single major equipment item failure (e.g., outage of the primary means for processing liquid wastes).
  - B. The system capability to accept additional wastes during operations which result in excessive liquid waste generation.
  - C. The total system capability to process liquid wastes at design-basis source term levels is evaluated based on information presented in SRP Section 11.1 and in this SRP section. The source term is based on a combination of assumptions of failed fuel fractions, BWR offgas release rates, TS limits for halogens and noble gases, presence of activation and corrosion products, and steam generator TS limits on allowable primary-to-secondary leakage rates. The design basis of the reactor coolant and reactor steam source terms is based on:
    - 1) an offgas system noble gas release rate of 3.7 megabecquerels per second per megawatt thermal (MBq/s per MWt) (100 microcuries ( $\mu$ Ci)/s per MWt) measured or estimated after a 30-minute delay for BWRs;
    - 2) an assumed 1 percent fuel cladding defects for PWRs; and
    - 3) technical specification limits for halogens (I-131 dose equivalent) and noble gases (Xe-133 dose equivalent), as defined in plant-specific TS.
  - D. Types and characteristics of filtration systems, ion-exchange resins, and adsorbent media (activated charcoal), and use of other treatment technologies, as described in the application, to treat process and effluent streams with removal efficiencies, decontamination factors, and holdup times meeting or exceeding the performance criteria of RG 1.112 and guidance of NUREG-0016 or NUREG-0017, as modified to reflect specific design features, and DC/COL-ISG-05 in the use of GALE86. The above information may be drawn from standard DCs, or topical reports, taking into account the expected processing flow rates and volumes, and the physical, chemical, and radiological properties of liquid process and effluent streams.
  - E. Justification for automatic control features and placement of isolation valves and radiation detectors on process piping and effluent discharge lines to ensure the

timely closure of such valves upon the detection of elevated radioactivity levels, and, if part of the design, controls in monitoring deviations of in-plant dilution flow rates in terminating releases or isolating process flows when deviations exceed preset limits. Other considerations may include determining whether system logic demands that a valve or damper should fail in the closed position in protecting the system from further contamination, terminating releases to the environment, or diverting process streams or effluents to appropriate treatment subsystems. Acceptable guidance is presented in SRP Section 11.5 and ANS N42.18-2004.

The average input flow rates and volumes are compared with the design flows to determine the fraction of time individual subsystems must be online to process normal waste input volumes. The review considers the operational flexibility designed into the system (i.e., cross-connections between subsystems, redundant or reserve processing equipment, reserve storage capacity, and reliance on mobile processing systems). Based on the usage factors and operational flexibilities, an evaluation of the overall system capability to process and control wastes as related to Items A, B, C, and D, above, is performed by comparing design flow rates and volumes with the potential process routes and equipment capacities.

It will be assumed that the primary means for processing liquid waste is unavailable for 2 consecutive days per week for maintenance. If a 2-day holdup capacity or a primary water processing source is not available for the process stream, it will be assumed that the waste stream is processed by an alternate method or discharged to the environment, consistent with an effluent source term developed using the guidelines referred to in NUREG-0016 or NUREG-0017 and RG 1.112, with plant parameters modified to reflect specific design features. If the alternate method includes the use of mobile processing systems connected to permanently installed LWMS subsystems, the staff will conduct a parallel review and evaluation of such a method using the above guidance and acceptance criteria.

5. The quality group and safety classifications of piping and equipment within the LWMS are compared to the guidelines of RGs 4.21 and 1.143 for liquid wastes produced during normal operation and AOOs. The seismic design criteria of equipment and structures housing the LWMS are also compared to the design guidance identified in RG 1.143. When applicable, SRP Sections 3.2.1, 3.2.2, 3.3.1, 3.3.2, 3.5.3, 3.7.1 through 3.7.4, 3.8.4, and 3.8.5 will be used to evaluate exceptions.
6. The LWMS is reviewed to ensure that the design includes provisions to prevent and collect leakage resulting from overflows and spillage from indoor and outdoor storage tanks containing liquids and liquid wastes, and meets the requirements of 10 CFR 20.1406. The review will confirm that:
  - A. Adequate design features exist, supplemented with operating programs, processes and procedures (as necessary), and these provide reasonable assurance that spills, leaks, and inadvertent discharges of radioactive liquid waste or effluents will be prevented or minimized.
  - B. In the event that a spill, leak, or inadvertent discharge does occur, the staff should verify that there is reasonable assurance that it will be detected in a timely manner. For those SSCs that are typically inaccessible for routine inspection or

observation, leak detection capability, to the extent practical, should allow for the identification and measurement of relatively small leak rates (e.g., several gallons per week), depending on the concentration of radioactive materials and leak/spill rates.

- C. Design features are supplemented, as necessary, by operating programs, processes, and procedures to monitor spills and leaks and evaluate their impact to the environment and prevent uncontrolled and unmonitored radioactive releases to underlying soils, surface water bodies, and groundwater.
- D. The site has been adequately characterized and conceptual site models have been developed which define the site hydrogeological settings, including subsurface and surface migration pathways under both pre-construction and post-construction conditions. These models are needed to assist with the design of surface and groundwater monitoring and procedures, design of protective measures, carrying out remediation, and the planning of decommissioning activities. This review is driven by SRP Sections 2.4.1 and 2.4.12 and this SRP section as it relates to design features of relevant SSCs.
- E. Description of design features that facilitate decommissioning, including their role in the decommissioning process. These should include both design features (such as modular components and adequate space for equipment removal) and operating procedures to minimize the amount of residual radioactivity that will require remediation at the time of decommissioning.
- F. Description of site and plant facilities and plant operations to minimize the generation and volume of radioactive waste, both during operation and during decommissioning.
- G. Description of design features and applications of surface protective coatings on concrete floor surfaces in areas where process equipment is located and exposed surfaces in sumps and drain channels in following the guidance of RGs 1.54 and 4.21 in facilitating the decontamination of radioactivity.

In addressing the above, supporting NRC guidance includes the following:

- A. DC/COL-ISG-06, as incorporated in SRP Section 12.3-12.4.
- B. RGs 1.11, 4.21, and 1.143 for system process streams, liquid wastes, and liquid effluents produced during normal operation and AOOs; and NUREG/CR-3587 as it relates to techniques used in decommissioning light water reactors.
- C. SRP Sections 5.2.5, 5.4.8, 5.4.13, 9.1.2, 9.1.3, 9.2.4, 9.2.6, 9.3.2, 9.3.3, 9.3.4 and 10.4.8.
- D. IE Bulletins Nos. 80-05 and 80-10; IE Circulars 81-09, 77-10, 77-14, 79-07, 79-09, 79-21, and 80-18; Information Notices (IN) 2004-05, 2006-13, and 2012-05; and RIS 2008-03.

- E. Industry guidance and standards NEI 08-08A, ANS N42.18-2004, ANSI/ANS-55.6-1993 (R2007), ANSI/ANS-40.37-2009, and ANSI/ANS 18.1-1999.
7. The system design, system and building layout, equipment design, method of operation, and provisions to reduce leakage and facilitate operations and maintenance are compared to the guidelines of RG 4.21 and RG 1.143 for liquids and liquid wastes produced during normal operation and AOOs. Topical reports on system design, including design features provided to control leakage from system components or to prevent placing or operating the system under adverse vacuum conditions, are reviewed on a case-by-case basis.
- RG 1.143 describes design guidance acceptable to the NRC staff related to seismic, safety, and quality group classifications and QA provisions for SSCs of the LWMS for liquids and liquid wastes produced during normal operation and AOOs and natural phenomena and man-induced hazards. In classifying system components, the radioactivity inventories of components are compared to the acceptance criteria in determining the appropriate safety classification. Meeting the guidance of RG 1.143 provides reasonable assurance that the assigned safety classifications for SSCs housing the LWMS and its components comply with the requirements of GDC 2 and 61.
8. The SREC, ODCM, and Administrative Controls Section of the TS proposed by the applicant for process and effluent controls will be evaluated as part of the review identified in SRP Sections 11.5, 13.4, 13.5, and 16.0. The reviewer will determine whether the content of the SREC and ODCM, calculation methods, and scope of the programs identified in the Administrative Controls Section of the TS are in agreement with the requirements identified as a result of the staff's review. The review will include the evaluation or development of appropriate controls and limiting conditions for operation and their bases as being consistent with the plant design. The ODCM, SREC, and TS are reviewed with respect to the requirements of 10 CFR 50.34a and 10 CFR 50.36a, using Generic Letter 89-01 and guidance contained in NUREG-1301 (PWR) or NUREG-1302 (BWR) and NUREG-0133 for either reactor type. Alternatively, a COL applicant may endorse by reference NEI 07-09A, "Generic FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description" (ADAMS Accession No. ML091050234), as the basis of the ODCM until a plant-and site-specific ODCM is developed before fuel load as described in SRP Section 13.4.
9. BTP 11-6 describes acceptable methods to evaluate the consequences associated with the release of radioactive liquids following the postulated failure of a tank and its components, and radiological consequences on the nearest point of entry into a water supply (surface water body and groundwater) and dose receptor, located in an unrestricted area. The associated exposure pathways include direct and indirect human water consumption. Indirect consumption includes the use of water for livestock, irrigation of grazing pastures, consumption of animal products (meat and milk products), fish and invertebrate consumption, crop irrigation and consumption of such crops, and use as an ingredient in food products or food processing. The analysis and results proposed by the applicant will be evaluated using the guidance of BTP 11-6 and its acceptance criteria. SRP Sections 2.4.12 and 2.4.13 present information and guidance on modeling the transport of associated radioactivity in groundwater and surface water bodies. The reviewer will evaluate the type of event leading to the assumed failure of a tank and components; the assumed radioactive source term, as radionuclide

concentrations and total inventory of radioactivity; the process by which the radioactivity is assumed to be released in the environment from plant facilities; the use of plant design features and credit assumed in mitigating the amounts of radioactivity released and duration of the release; the basis for the selection of the nearest point of entry into a surface water body and groundwater; dispersion and dilution mechanisms from the release to the nearest point of entry and dose receptor; dose receptors and types of exposure pathways considered; and the resulting radionuclide concentrations at the nearest point of entry and dose receptor location.

The reviewer will determine whether the analytical approach, assumptions, and model parameters used in assessing the radiological impacts are adequately conservative, consistent with the guidance of BTP 11-6, and confirm whether the acceptance criteria of BTP 11-6 are met at the nearest point of entry and dose receptor. Alternatively, for plant system features and site characteristics incapable of meeting the acceptance criteria of BTP 11-6, the reviewer will evaluate proposed special design features applied in mitigating the effects of a postulated tank failure and determine whether such design features are adequate and acceptable given the objectives of BTP 11-6 in protecting public health and safety and surface water and groundwater. If the results of a plant- and site-specific analysis do not meet BTP 11-6 acceptance criteria, the applicant should propose TS limiting the total amount of radioactivity in such tanks and components, as adopted from standard technical specifications (NUREG-1430, NUREG-1431, NUREG-1432, NUREG-1433, and NUREG-1434). The staff will evaluate the proposed TS limiting the total radioactivity inventory of liquid-containing tanks and components to ensure that the TS are consistent with the results of the consequence analysis. The staff will confirm that DC/COL FSAR Chapter 16, Section 5.5, "Programs and Manuals," identifies the requirements for the TS.

10. In determining compliance with the EPA generally applicable environmental radiation standards of 40 CFR Part 190, as required by 10 CFR 20.1301(e), the review considers all sources of radiation and radioactivity as potential contributors to doses to members of the public from the site, whether from single or multiple reactor units. The review focuses on sources of radioactivity as gaseous and liquid effluents, and external radiation exposures from buildings, storage tanks, and radioactive waste storage buildings. This section of the SRP provides guidance for the staff's evaluation of the source terms and associated doses from liquid effluents, while SRP Sections 11.3 and 11.4 provide guidance in evaluating the source terms and doses from gaseous effluents and solid wastes. In turn, SRP Section 11.5 addresses the means of demonstrating compliance with all sources of effluents. SRP Section 12.3-12.4 provides guidance for the staff to evaluate doses associated with external radiation from buildings and sources of radioactivity contained in systems and components.

For OL and COL applicants with site-specific information on the locations of offsite dose receptors, compliance with the EPA standards requires consideration of whether doses due to liquid and gaseous effluent releases and external radiation are additive or need to be addressed separately given actual exposure pathways. The location of offsite dose receptors and the determination of actual exposure pathways should be based on the results of a current land use census for the site. The reviewer should determine whether the applicant has applied site-specific information in assigning doses for all identified exposure pathways, or instead has assumed that all exposures occur at one location in bounding dose estimates, where doses from liquid and gaseous effluent releases and external radiation are summed up and compared to the EPA standards. In such

instances, the applicant should provide a commitment to reassess compliance with the EPA standards, as implemented under 10 CFR 20.1301(e), by appropriately assigning doses with actual exposure pathways once site-specific information becomes available on their locations within the vicinity of the site.

11. 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 and site parameters) set forth in the FSAR meets NRC regulations, guidance, and acceptance criteria. 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 in a COL application, they should be added to FSAR, Sections 1.8 and 11.2.

For the review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an ESP, other NRC approvals (e.g., manufacturing license, site suitability report or topical report), or proposes other reactor technology. 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 reviews of both DC and COL applications, SRP Section 14.3 and RG 1.215 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of the review under this section.

For reviews of a COL application relying on a DC, 10 CFR 52.63 precludes the staff from imposing new requirements on DCs unless it is deemed necessary to bring the certification in 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, 2, or Tier 2\* information), then it must also follow the appropriate change process in Section VIII of the DC rule. 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.

In instances where an applicant has submitted conceptual design information for portions of the plant for which the application does not seek certification, the review should confirm that the applicant has submitted sufficient details for the staff to conduct its evaluation of the associated SSCs, assess the adequacy of interface requirements with other SSCs that are included in the DC, ensure that the application continues to include an essentially complete design, and confirm the adequacy of proposed ITAAC and methods used in verifying that all interface requirements have been met by a COL applicant under the requirements of 10 CFR 52.47(a)(24) through 52.47(a)(26), 10 CFR 52.79(d)(2), and 10 CFR 52.80(a).

12. 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.

For an ESP application, the staff reviews the estimates of the source terms for liquid radioactive effluents and radionuclide concentration levels at the site boundary, identified points of discharge or release into the environment, and at all appropriate offsite dose receptor locations and potential exposure pathways. The estimates of the effluent source terms (Ci/yr) and effluent concentrations ( $\mu\text{Ci/ml}$ ) are evaluated to determine whether they are consistent with the range of possible thermal power levels. The staff should confirm the approach used by the applicant in developing the annual average liquid effluent source term. For a 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 for the selected reactor technology. For a 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 DC or other reactor technology and conservatively bounding over all expected radionuclides and estimate of releases.

In the absence of certain circumstances, such as a compliance or adequate protection issue, 10 CFR 52.39 precludes the staff from imposing new site characteristics, design parameters, or terms and conditions on issues that were resolved as part of the ESP at the COL stage. The applicant 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 reviewer should ensure that physical attributes (relevant to the review conducted under 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, and conditions stipulated in the ESP, including COL action items.

The staff should confirm that exposure pathways are based on site-specific or regional land-use information and include all appropriate dose receptors. Exposure pathways should include consumption of drinking water (ground and surface water); ingestion of aquatic food; use of water in food processing or as an ingredient; crop and pasture irrigation; livestock watering; ingestion of animal and agricultural products subjected to watering or irrigation; exposure to shoreline sediment, and exposure to water through boating and swimming activities. The staff's conclusion of acceptability is based on site-specific data and assumptions presented by the applicant as to the types of exposure pathways and locations of dose receptors. However, should future local land-use information reveal that new and different exposure pathways and dose receptors exist from that described in the ESP, the ESP applicants should identify this possibility and flag it as a COL action item for consideration by COL applicants. The COL action item should indicate the necessity to consider new exposure pathways, when different than those described in the ESP, and conduct a new dose assessment and confirm that associated doses are in compliance with NRC regulations and applicable guidance.

#### IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the staff's safety review and analysis conducted in accordance with the staff's review approach described

in the SRP Introduction, support conclusions of the following types to be included in the staff's SER. The reviewer also states the basis for those conclusions. When programmatic elements are used to assess design adequacy and effects on the development of new or modifications of existing operational programs, 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 staff concludes that the LWMS (as a permanently installed system or in combination with mobile systems) includes the equipment necessary to control releases of radioactive materials in liquid effluents in accordance with GDC 60 and 61 of Appendix A to 10 CFR Part 50 and the requirements of 10 CFR 50.34a. The staff concludes that the design of the LWMS is acceptable and meets the requirements of 10 CFR 20.1301 and 20.1302; 10 CFR 20.1406; 10 CFR 50.34a and 10 CFR 50.36a; 10 CFR 50.34(f); GDC 2, 3, 60 and 61; and design objectives and ALARA provisions of Appendix I to 10 CFR Part 50.

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

1. The applicant has met the requirements of Section II.A of Appendix I to 10 CFR Part 50 with respect to dose limiting objectives by proposing a LWMS design that is capable of maintaining releases of radioactive materials in liquid effluents such that the calculated individual doses in an unrestricted area from all pathways of exposure are less than 0.03 mSv (3 mrem) to the total body and 0.1 mSv (10 mrem) to any organ. The staff's evaluation has considered releases of radioactive materials in liquid effluents for normal operation, including AOOs, based on expected radwaste inputs over the life of the plant for each reactor on the site, in accordance with the guidance of SRP Section 11.1.

The applicant has met the requirements of Section II.D of Appendix I to 10 CFR Part 50 with respect to meeting the ALARA criterion. The staff has considered the potential effectiveness of augmenting the proposed LWMS using items of reasonably demonstrated technology and has determined that further effluent treatment will not effect reductions in cumulative population doses reasonably expected within an 80-km (50-mile) radius of the reactor and the proposed LWMS complies with the cost-benefit ratio of Section II.D of Appendix I.

2. The applicant has met the requirements of 10 CFR 20.1301 and 20.1302, as the staff has considered the potential consequences resulting from reactor operation with design basis fuel defect level fission product inventory in the core for PWRs or offgas noble gas release rate assumed after 30-minute decay for BWRs, and TS limits for dose equivalent halogens and noble gases. The design basis fuel defect level for PWRs and noble gases release rate for BWRs were reviewed using the guidance in SRP Sections 11.1 and the guidance of SRP Section 11.2 as radioactive source terms to the primary and secondary coolant and reactor steam. The staff has determined that under these conditions, the concentrations of radioactive materials in liquid effluents discharged in unrestricted areas will comply with the concentration limits specified in Table 2, Column 2, and Note 4 of Appendix B to 10 CFR Part 20. In making the above determination for radioiodines, the staff has considered TS limits for iodine-131 dose equivalent concentration in the primary and secondary coolant for PWR and BWR designs, as defined in the plant TS.
3. The staff has reviewed the sources of radiation and radioactivity and associated doses to members of the public and concludes that annual doses from all sources of

radioactivity and radiation from the site (which may have either a single or multiple reactor units), including liquid and gaseous effluents and external radiation exposures from buildings and storage tanks, and N-16 skyshine from BWR turbine buildings as sources of external radiation, will not exceed the EPA generally applicable environmental radiation standards of 40 CFR Part 190 as implemented under 10 CFR Part 20.1301(e). SER Section 12.3-12.4 evaluates the doses associated with external radiation from buildings and sources of radioactivity contained in systems and components.

4. The applicant has met the requirements of 10 CFR 20.1406 with respect to providing a description of how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment; facilitate eventual decommissioning; and minimize, to the extent practicable, the generation of radioactive waste, with supplemental information presented in FSAR Section 12.3-12.4. The staff concludes that the proposed design features and operational programs and procedures are consistent with NRC guidance and the requirements of 10 CFR 20.1406.
5. The applicant has met the requirements of GDC 60 and 61 with respect to controlling releases of radioactive materials to the environment. The staff has considered the ability of the proposed liquid radwaste treatment management system to meet the demands of the plant resulting from AOOs and has concluded that the system capacity and design flexibility are adequate to meet the anticipated needs of the plant. In controlling releases to the environment, the staff has found the design of automatic control features acceptable in terminating liquid effluent discharges or diverting process flows to subsystems for storage and further processing. Supplemental information on radiological instrumentation monitoring and controls is presented and evaluated under SER Section 11.5. The staff has reviewed the applicant's vacuum mitigating provisions for the LWMS and found these features to be in compliance with GDC 60 and 61.
6. The staff has reviewed the applicant's quality assurance provisions for the LWMS, the quality group and safety classifications used for system components, and the seismic design applied to structures housing these systems. The design of the systems and structures housing these systems meets the guidelines of RG 1.143, for liquids and liquid wastes produced during normal operation and AOOs. Meeting the guidance of RG 1.143 provides reasonable assurance that the assigned safety classifications for structures housing the LWMS and its components comply with the requirements of GDC 2 and 61, and the guidance of RG 1.143 for natural phenomena and man-induced hazards. Meeting the guidance of SRP Sections 11.2 and 2.4.13 and BTP 11-6 (as referenced in SRP Section 11.2), and using the analysis of RG 1.143 in assigning the safety classifications to SSCs of the LWMS, provide reasonable assurance that the design meets the requirements of GDC 2 and 61.
7. Based on the staff's review of the LWMS fire protection program on the management of flammable and combustible radioactive wastes (e.g., spent resins and activated charcoals) presented here and in SER Sections 9.5 and 11.4, the staff finds the scope of the fire protection program and operational safeguards adequate as they relate to system design features and commitment to conduct fire hazards analyses involving the presence of combustible or flammable materials. The inclusion of facility and system design features and elements of the fire protection program in managing radioactive materials provides reasonable assurance that the facility design and proposed

operations comply with 10 CFR Part 20 using the guidance of RGs 1.189 and 1.205 in protecting workers and members of the public.

8. The staff has reviewed the provisions incorporated in the applicant's design to control the release of radioactive materials in liquids resulting from inadvertent tank overflows, avoid the contamination of nonradioactive systems, prevent uncontrolled and unmonitored releases of radioactive materials in the environment, and avoid interconnections with potable and sanitary water systems and concludes that the measures proposed by the applicant meet the requirements of GDC 60 and 61 and guidance of RG 1.143 and 4.21 for liquids and liquid wastes produced during normal operation and AOOs.
9. There are no specific operational programs required for the operation of the LWMS. All liquid effluent releases associated with the operation of the LWMS are controlled by the ODCM. The applicant has committed, SRP Sections 11.5 and 13.4, to develop a plant- and site-specific ODCM before fuel load based on NEI ODCM Template 07-09A. The staff's evaluation of the ODCM and acceptability of NEI ODCM Template 07-09A are discussed in SRP Section 11.5.
10. If applicable, the staff has reviewed the proposed augmentation of programmatic elements in assessing the adequacy of the LWMS design and resulting effects on the development of the radioactive liquid effluent source terms. The staff's evaluation and conclusion of the acceptability of the augmented programmatic elements is addressed in SER Section 13.4 and the relevant requirements and guidance are identified in the appropriate SER sections for the subsystems and components identified in the supplemental or new programmatic elements. The staff concludes that the proposed augmentation of programmatic elements is acceptable and consistent with the ALARA principle described in 10 CFR 20.1101(b) and 10 CFR Part 50, Appendix I design objectives.
11. With respect to the consequence analysis addressing the radiological impact due to the postulated failure of a tank containing radioactive liquids, the applicant provided the results of a site-specific analysis demonstrating compliance with the acceptance criteria of SRP Sections 2.4.12, 2.4.13, and 11.2 with BTP 11-6. Supporting information on the staff's evaluation of the applicant's results and conclusions on geo-hydrological characteristics of the site and transport of radioactivity in surface and groundwater to unrestricted areas is presented in SER Sections 2.4.12 and 2.4.13. The staff concludes that the analysis provided by the applicant is consistent with the guidelines of BTP 11-6 and meets the acceptance criteria defined in BTP 11-6 for an offsite individual using the nearest water supply for direct and indirect human consumption. Depending upon whether special design features were incorporated to mitigate the consequences of a tank failure or the applicant has proposed TS limiting the total amount of radioactivity in such tanks, the specific conclusions and evaluation findings of the staff will be drawn from those listed in BTP 11-6. The staff will introduce the appropriate evaluation findings here, based on the information presented by the applicant and results of the staff's evaluation in confirming the results and conclusions of the consequence analysis.

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 and confirm that the applicant has met NRC requirements and guidance described in the application. If requested by the COL applicant, the findings will

confirm whether the Part 52 licensing process for seeking exemptions, changes, and departures in the COL application was observed in changing specific features of the DC in FSAR Tier 1, Tier 2, and Tier 2\* information, and that resulting changes in plant design features and operations will ensure compliance with NRC regulations and guidance once the facility is constructed and operating in conformity with the COL.

In instances where an applicant has submitted conceptual design information for portions of the plant for which the application does not seek certification, the findings will summarize the staff's evaluation in confirming that the applicant has submitted supplemental design details for the associated SSCs, adequately addressed interface requirements with other SSCs that are included in the DC, and determined the adequacy of the proposed ITAAC and methods used in verifying that all interface requirements have been met by the COL applicant under the requirements of 10 CFR 52.47(a)(24) through 52.47(a)(26), 10 CFR 52.79(d)(2), and 10 CFR 52.80(a).

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of ITAAC in SER Section 14.3.7 and supporting information drawn from Tier 1 material.

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 SRP Sections 11.1 and 11.2) 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 confirms that the ESP applicant has identified the appropriate COL action items, as warranted, in recognition that future local land-use information may reveal that new and different exposure pathways and dose receptors exist from that described in the ESP. The COL action items flag the necessity to consider new exposure pathways, when different than those described in the ESP, and conduct a new dose assessment and confirm that associated doses are in compliance with NRC regulations and applicable guidance.

## V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of ESP, CP, DC, OL or COL applications submitted by applicants pursuant to 10 CFR Part 50 and 10 CFR Part 52. The staff will use the method described herein to evaluate conformance with Commission regulations as noted below. With respect to demonstrating conformance with the SRP, NRC regulations state, in part, that the application must contain "an evaluation of the standard plant design against the SRP revision in effect 6 months before the docket date of the application." An applicant is required to identify differences between this SRP section 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)(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. 10 CFR 20.1301, "Dose Limits for Individual Members of the Public."
2. 10 CFR 20.1302, "Compliance with Dose Limits for Individual Members of the Public."
3. 10 CFR 20.1406, "Minimization of Contamination."
4. 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."
5. 10 CFR 50.34, "Contents of applications; technical information."
6. 10 CFR 50.34a, "Design objectives for equipment to control releases of radioactive material in effluents nuclear power reactors."
7. 10 CFR 50.36a, "Technical specifications on effluents from nuclear power reactors."
8. 10 CFR 50.59, "Changes, Tests, and Experiments."
9. 10 CFR Part 50, Appendix A, GDC 2, "Design bases for protection against natural phenomena."
10. 10 CFR Part 50, Appendix A, GDC 3, "Fire protection."
11. 10 CFR Part 50, Appendix A, GDC 60, "Control of releases of radioactive materials to the environment."
12. 10 CFR Part 50, Appendix A, GDC 61, "Fuel storage and handling and radioactivity control."
13. 10 CFR Part 50, Appendix B, "Quality assurance criteria for nuclear power plants and fuel reprocessing plants."
14. 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."
15. 10 CFR 52.39, "Finality of early site permit determinations."
16. 10 CFR 52.47, "Contents of applications; technical information."
17. 10 CFR 52.63, "Finality of standard design certifications."
18. 10 CFR 52.80, "Contents of applications; additional technical information."
19. 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

20. ANSI/ANS-55.6-1993 (R2007), "Liquid Radioactive Waste Processing System for Light Water Reactor Plants," Reaffirmed in 2007.
21. ANSI/ANS-40.37-2009, "American National Standard, Mobile Low-Level Radioactive Waste Processing Systems," 2009. .
22. ANSI N42.18-2004, "Specification and Performance of On Site Instrumentation for Continuously Monitoring Radioactivity in Effluents," 2004.
23. ANSI/ANS-18.1-1999, "American National Standard Radioactive Source Term for Normal Operation of Light Water Reactors," 1999.
24. DC/COL-ISG-05, "Interim Staff Guidance on the use of the 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," July 2008.
25. DC/COL-ISG-06, "Final Interim Staff Guidance Evaluation and Acceptance Criteria for 10 CFR 20.1406 to Support Design Certification and Combined License Applications," as incorporated in SRP Section 12.3-12.4.
26. DC/COL-ISG-013, "Assessing the Radiological Consequences of Accidental Releases of Radioactive Materials from Liquid Waste Tanks for Combined License Applications."
27. GL 89-01, "Implementation of Programmatic Controls for Radiological Effluent Technical Specifications in the Administrative Controls Section of the Technical Specifications and the Relocation of Procedural Details of RETS to the Offsite Dose Calculation Manual or to the Process Control Program (Generic Letter 89-01)."
28. IE Bulletin No. 80-05, "Vacuum Condition Resulting in Damage to Chemical Volume Control System (CVCS) Holdup Tanks (Sometimes Called "Clean Waste Receiver Tanks")" March 10, 1980.
29. IE Bulletin No. 80-10, "Contamination of Nonradioactive System and Resulting Potential for Unmonitored, Uncontrolled Release of Radioactivity to Environment," May 6, 1980.
30. IE Circular No. 77-10, "Vacuum Conditions Resulting in Damage to Liquid Process Tanks," July 15, 1977.
31. IE Circular No. 77-14, "Separation of Contaminated Water Systems from Uncontaminated Plant Systems," November 22, 1977.
32. IE Circular No. 79-21, "Prevention of Unplanned Releases of Radioactivity," October 17, 1979.
33. IE Circular No. 80-18, "10 CFR 50.59 Safety Evaluations for Changes to Radioactive Waste Treatment Systems," August 22, 1980, implemented using RG 1.187.
34. IE Circular No. 81-09, "Containment Effluent Water that Bypasses Radioactivity Monitor," July 10, 1981.

35. IE Information Notice No. 79-07, "Rupture of Radwaste Tanks," March 23, 1979.
36. IE Information Notice No. 79-09, "Spill of Radioactively Contaminated Resin," March 30, 1979.
37. IE Information Notice No. 83-14, "Dewatered Spent Ion Exchange Resin Susceptibility to Exothermic Chemical Reaction," March 21, 1983.
38. IE Information Notice No. 84-72, "Clarification of Conditions for Waste Shipments Subject To Hydrogen Gas Generation," September 10, 1984.
39. IE Information Notice No. 88-08, "Chemical Reactions with Radioactive Waste Solidification Agents," March 14, 1988.
40. IE Information Notice No. 90-50, "Minimization of Methane Gas in Plant Systems and Radwaste Shipping Containers," August 8, 1990.
41. IN 2004-05, "Spent Fuel Pool Leakage to Onsite Groundwater," March 3, 2004
42. IN 2006-13, "Ground-Water Contamination Due to Undetected Leakage of Radioactive Water," July 10, 2006.
43. IN 2012-05, "Abnormal Releases of Radioactive Water Potentially Resulting in Groundwater Contamination," April 25, 2012.
44. NEI 07-09A, "Generic FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description," Revision 0, March 2009,
45. NEI 08-08A, "Generic FSAR Template Guidance for Life Cycle Minimization of Contamination," Revision 0, October 2009.
46. NEI 97-06, "Steam Generator Program Guidelines," 1997.
47. NUREG-0016, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors (BWRs)
48. NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWRs).
49. NUREG-0800, Section 5, Branch Technical Position (BTP) 5-1 "Monitoring of Secondary Side Water Chemistry in PWR Steam Generators."
50. NUREG-0800, Section 11.2, BTP 11-6, "Postulated Radioactive Releases Due to Liquid Containing Tank Failures," as revised under ISG-013.
51. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition."
52. NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants."

53. NUREG-0933, "Resolution of Generic Safety Issues (Formerly entitled "A Prioritization of Generic Safety Issues."
54. NUREG-1301, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors."
55. NUREG-1302, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors."
56. NUREG-1430, "Standard Technical Specifications - Babcock and Wilcox Plants."
57. NUREG-1431, "Standard Technical Specifications - Westinghouse Plants."
58. NUREG-1432, "Standard Technical Specifications - Combustion Engineering Plants."
59. NUREG-1433, "Standard Technical Specifications - General Electric Plants (BWR/4)."
60. NUREG-1434, "Standard Technical Specifications - General Electric Plants (BWR/6)."
61. NUREG/CR-4013, "LADTAP II - Technical Reference and User Guide."
62. NUREG/CR-3587, "Identification and Evaluation of Facility Techniques for Decommissioning of Light Water Reactors."
63. NUREG/CR-4601, "Technical Considerations Affecting Preparation of Ion Exchange Resins for Disposal."
64. RIS 2008-03, "Return/Re-use of Previously Discharged Radioactive Effluents"
65. RG 1.11, "Instrument Lines Penetrating Primary Reactor Containment."
66. RG 1.33, "Quality Assurance Program Requirements (Operation)."
67. RG 1.54, "Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants."
68. RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants."
69. RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."
70. RG 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants."
71. RG 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light Water Cooled Nuclear Power Reactors."
72. RG 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I."
73. RG 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluent from Light-Water-Cooled Power Reactors."

74. RG 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I."
75. 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."
76. RG 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light Water Cooled Nuclear Reactor Power Plants."
77. RG 1.187, "Guidance for Implementation of 10 CFR 50.59 Changes, Tests, and Experiments."
78. RG 1.189, "Fire Protection for Nuclear Power Plants."
79. RG 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants."
80. RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."
81. RG 1.215, "Guidance for ITAAC Closure Under 10 CFR Part 52."
82. Contamination and Radioactive Waste Generation: Life-Cycle Planning."
83. RG 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable."
84. RG 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable."

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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, 3150-0014 and 3150-0151.

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**SRP Section 11.2  
Description of Changes**

**SECTION 11.2 “Liquid Waste Management System”**

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in Section 11.2, Revision 4, dated May 2010. See ADAMS Accession No. ML100740449.

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

Technical changes incorporated in this revision include:

I. AREAS OF REVIEW

The areas of review section has been revised by identifying additional technical areas which warrant staff reviews and evaluations in assessing the design and performance characteristics of the LWMS in recognition of existing guidance and regulatory requirements. In part, the additional technical topics identified here also support the expanded topics listed in review interfaces. The additional areas of review address:

1. Quality assurance provisions for LWMS subsystems not covered by the requirements of 10 CFR Part 50, Appendix B, based on the guidance of RG 1.143.
2. Expanded discussions on design features to prevent, control, and collect radioactive materials in liquids from tank overflows from all plant systems and the potential for tanks located outside of the reactor containment that could result in uncontrolled and unmonitored releases, and design features applied to mitigate the effects of a postulated tank failure, e.g., steel liners, sumps, drains, or walls in areas housing tanks and components, dikes and retention basins for outdoor tanks, and provisions to accommodate overflow conditions by routing flows to appropriate subsystems. The discussions now also refer to RG 1.54 and RG 4.21 and industry guidance under NEI 08-08A.
3. For processing subsystems equipped with automatic control features, justification for the placement of isolation or diversion valves and radiation detectors on process piping and effluent discharge lines to ensure the timely closure of such valves upon the detection of elevated radioactivity levels, and, if part of the design, controls in monitoring deviations of in-plant dilution flow rates and terminating releases or isolating process flows when deviations exceed preset limits.
4. Design features and operational safeguards to prevent the introduction and mixing of chemical additives with ion-exchange resins to avoid the generation of exothermic reactions and explosive gas mixtures in LWMS components.
5. For plant designs with impoundment facilities and cooling ponds/canals through which LWMS radioactive effluents are discharged to unrestricted areas, descriptions of design features credited in meeting the requirements of 10 CFR 20.1406. The discussion addresses how engineered design features and leakage detection monitoring methods satisfying the regulatory requirements of other Federal and state agencies also

demonstrate compliance with 10 CFR 20.1406 and guidance of RG 4.21 in minimizing the contamination of plant discharges in the environment, including groundwater and surface water.

6. The listing of plant systems identified in review interfaces has been expanded to ensure that the staff's review of radiological considerations is properly integrated with parallel and complementary evaluations conducted by other technical disciplines. For systems that contribute potential input liquid wastes to process streams and effluents managed by the LWMS, the following SRP sections were identified with technical and regulatory interfaces. The SRP Sections are 1.8, 1.9, 2.1.2, 2.4.1, 5.2.5, 5.4.8, 5.4.13, 7.1, 7.5, 7.6, 7.7, 9.1.2, 9.1.3, 9.2.3, 9.2.6, 9.3.3, 9.3.4, 10.4, 11.3, 11.4, 12.3-12.4, 13.3, 13.4, 13.5, 14.2, and 14.3 and associated BTPs as noted in each SRP section.

## II. ACCEPTANCE CRITERIA

The acceptance criteria section was revised by including citations to existing regulatory requirements not cited in the prior SRP and providing clarification on methods used in calculating radioactive source terms and doses to members of the public in demonstrating compliance with 10 CFR Part 20 and 10 CFR Part 50, Appendix I. The major revisions include:

1. Addition of 10 CFR Part 20.1101(b), as it relates to the use of procedures and engineering controls in maintaining doses to members of the public ALARA.
2. 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2, as it relates to the design bases of structures housing LWMS and its components using the guidance of RG 1.143 in assigning seismic and quality group classifications, and safety classifications for natural phenomena and man-induced hazards as defined in RG 1.143 in assigning safety classifications to LWMS SSCs for design purposes.
3. 10 CFR Part 50, Appendix A, GDC 3, as it relates to the design of LWMS subsystems and operational safeguards to avoid the generation of explosive gas mixtures and exothermic reactions through the inadvertent introduction and mixing of chemical agents with ion-exchange resins using the guidance in RGs 1.189 and 1.205 in conducting fire hazards analyses involving the presence of radioactivity in combustible or flammable materials. Using GDC 3 as guidance provides assurance that radioactive materials are protected from the effects of fires and that the function of plant systems and components will not be compromised in meeting effluent discharge concentration limits of 10 CFR Part 20 associated with releases of contaminated fire protection water and combustion gases and smoke.
4. 10 CFR Part 50, Appendix A, GDC 61, as it relates to the ability of the LWMS design to ensure adequate safety under normal and postulated accident conditions, as noted in SRP Sections 2.4.13 and 11.2 (with BTP 11-6) and analysis of RG 1.143 in assigning the safety classifications to LWMS SSCs for design purposes.
5. 40 CFR Part 190 (the U.S. Environmental Protection Agency's (EPA) generally applicable environmental radiation standards), as implemented under 10 CFR 20.1301(e), as it relates to limits on annual doses from all sources of radioactivity contained in liquid effluents and external radiation from site buildings and facilities (with single or multiple reactor units). The guidance has been expanded in

evaluating compliance with the standards for sites that have site-specific information on the locations of offsite dose receptors, and those that do not.

6. 10 CFR 52.17(a)(ii), for ESP applications as relevant requirement to releases and doses under 10 CFR Part 20 and Appendix I to 10 CFR Part 50, such that the design objectives of Section II.A can be met based on anticipated levels of radioactive effluents released in plant environs.
7. Revised staff guidance presented in: DC/COL-ISG-05, 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 or NUREG-0017 and ANSI/ANS 18.1-1999 have been updated in a newer version of the associated computer GALE code, as GALE86 – see ADAMS Accession ML081710264.
8. Clarification in developing design basis reactor coolant and reactor steam source terms when considering technical specification limits for halogens (I-131 dose equivalent) and noble gases (Xe-133 dose equivalent), as applied in analyses conducted in SRP Sections 11.1 and 11.3.
9. DC/COL-ISG-013, "Assessing the Radiological Consequences of Accidental Releases of Radioactive Materials from Liquid Waste Tanks for Combined License Applications," as it relates to guidance on reviewing the analysis of the radiological consequences of accidental releases of radioactive materials to groundwater and surface water.
10. Clarification on the application of RG 1.143 acceptance criteria related to seismic, safety, and quality group classifications and quality assurance provisions for structures, systems, and components of the LWMS produced during normal operation and AOOs. RG 1.143 provides guidance in assigning safety classifications to structures and liquid waste management systems in protecting SSCs against natural phenomena and man-induced hazards. The acceptance criteria are revised to conform with 10 CFR Part 20 dose limits for members of the public and plant workers and their assumed locations in restricted areas for workers and unrestricted areas for members of the public. Also, the revised guidance refers to RG 1.206, Part I, C.1.3, Sections 3.2.1 and 3.2.2 and SRP Section 3.8.4 in identifying applicable acceptance criteria in evaluating SSCs requiring seismic design considerations and differences from the recommendations of RG 1.143.
11. Additional clarification is provided on the use of automatic control features and placement of isolation valves and radiation detectors on process piping and effluent discharge lines to ensure the timely closure of such valves upon the detection of elevated radioactivity levels, and, if part of the design, controls in monitoring deviations of in-plant dilution flow rates in terminating releases or isolating process flows when deviations exceed preset limits. Other considerations include determining whether system logic demands that a valve or damper should fail in the closed position in protecting the system from further contamination, terminating releases to the environment, or diverting process streams or effluents to appropriate treatment subsystems.
12. For ESP applications, clarification is provided in reviewing the estimates of the source terms of liquid radioactive effluents and radionuclide concentration levels at the site

boundary. For a 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 for the selected reactor technology. For a 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 and conservatively bounding over all expected radionuclides and estimate of releases.

13. For ESP applications, clarification is provided for the staff in reviewing the results of a bounding dose assessment and demonstrate the capability to comply with 10 CFR Part 20 dose limits and 10 CFR Part 50, Appendix I design objectives. The staff's conclusion of acceptability is based on site-specific data assumptions presented by the applicant as to the types of exposure pathways and locations of dose receptors. However, should future local land-use information reveal that new and different exposure pathways and dose receptors exist from that described in the ESP, the applicant should identify this possibility and flag it as a COL action item for consideration in a COL application. The COL action item should flag the necessity to consider new exposure pathways, when different than those described in the ESP, and conduct a new dose assessment and confirm that associated doses are in compliance with NRC regulations and applicable guidance.
14. The revision provides guidance on the review of the proposed technical resolution of unresolved safety issues and medium- and high-priority generic safety issues (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 Three Mile Island requirements.
15. Updated listing of NRC and industry guidance reflecting operating experience – see updated reference list below.
16. The SRP guidance endorses NEI 08-08A, "Generic FSAR Template Guidance for Life Cycle Minimization of Contamination," (Revision 0, October 2009) in describing acceptable methods in complying with 10 CFR 20.1406 and guidance of RG 4.21.
17. The SRP guidance endorses NEI 07-09A, "Generic FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description," (Revision 0, March 2009) as an acceptable commitment in developing a plant- and site-specific ODCM before fuel load, as specified in SRP Sections 11.5 and 13.4.

### 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 in explanations above.

### 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 consequence analyses conducted under SRP Section 11.2 using the guidance in BTP 11-6.
2. Using RG 1.143, compliance with 10 CFR Part 50, Appendix A, GDC 2 and 61, as they relate to acceptance criteria related to seismic, safety, and quality group classifications and quality assurance provisions for SSCs of the LWMS for liquids and liquid wastes produced during normal operation and AOOs. The acceptance criteria are revised to conform with 10 CFR Part 20 dose limits for members of the public and plant workers, given assumed locations in restricted areas for workers and unrestricted areas for members of the public.
3. Development of radioactive source terms using the guidance in RG 1.112, NUREG-0016, NUREG-0017, DC/COL-ISG-05 in using GALE86, and 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. If applicable, proposed augmentation of programmatic elements in assessing the adequacy of the design and resulting effects on the development of associated radioactive liquid effluent source terms and compliance with 10 CFR Part 20 effluent concentration and dose limits and 10 CFR Part 50, Appendix I design objectives and ALARA provisions.
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.
6. Confirmation that the applicant has committed, given SRP Sections 11.5, 13.4, and 13.5, to develop a plant- and site-specific ODCM before fuel load, based on NEI ODCM Template 07-09A.

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 50.34, "Contents of Applications; Technical Information."
2. 10 CFR 50.59, "Changes, Tests, and Experiments."
3. 10 CFR Part 50, Appendix A, GDC 2, "Design Bases for Protection Against Natural Phenomena."
4. 10 CFR Part 50, Appendix A, GDC 3, "Fire Protection."

5. 10 CFR Part 50, Appendix B “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants.”
6. 10 CFR 52.39, “Finality of Early Site Permit Determinations.”
7. 10 CFR 52.47, “Contents of Applications; Technical Information.”
8. 10 CFR 52.63, “Finality of Standard Design Certifications.”
9. 10 CFR 52.80, “Contents of Applications; Additional Technical Information.”
10. 40 CFR Part 190, “Environmental Radiation Protection Standards for Nuclear Power Operations.”
11. ANSI/ANS-55.6-1993 (R2007), “Liquid Radioactive Waste Processing System for Light Water Reactor Plants,” Reaffirmed in 2007.
12. ANSI/ANS-40.37-2009, “American National Standard, Mobile Low-Level Radioactive Waste Processing Systems,” 2009.
13. ANSI N42.18-2004, “Specification and Performance of on Site Instrumentation for Continuously Monitoring Radioactivity in Effluents,” 2004.
14. ANSI/ANS-18.1-1999, “American National Standard Radioactive Source Term for Normal Operation of Light Water Reactors,” 1999.
15. DC/COL-ISG-05, “Interim Staff Guidance on the use of the 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,” July 2008
16. DC/COL-ISG-06, “Final Interim Staff Guidance Evaluation and Acceptance Criteria for 10 CFR 20.1406 to Support Design Certification and Combined License Applications,” as incorporated in SRP Section 12.3-12.4.
17. DC/COL-ISG-013, “Interim Staff Guidance on NUREG-0800 Standard Review Plan Section 11.2 and Branch Technical Position 11-6, Assessing the Radiological Consequences of Accidental Releases of Radioactive Materials from Liquid Waste Tanks for Combined License Applications,” as incorporated in BTP 11-6. (FRN Vol. 78, No. 19, p.6149, January 29, 2013).
18. IE Bulletin No. 80-05, “Vacuum Condition Resulting in Damage to Chemical Volume Control System (CVCS) Holdup Tanks (Sometimes Called “Clean Waste Receiver Tanks”),” March 10, 1980.
19. IE Circular No. 80-18, “10 CFR 50.59 Safety Evaluations for Changes to Radioactive Waste Treatment Systems,” August 22, 1980.
20. IE Information Notice No. 83-14, “Dewatered Spent Ion Exchange Resin Susceptibility to Exothermic Chemical Reaction,” March 21, 1983.

21. IE Information Notice No. 84-72, "Clarification of Conditions for Waste Shipments Subject to Hydrogen Gas Generation," September 10, 1984.
22. IE Information Notice No. 88-08, "Chemical Reactions with Radioactive Waste Solidification Agents," March 14, 1988.
23. IE Information Notice No. 90-50, "Minimization of Methane Gas in Plant Systems and Radwaste Shipping Containers," August 8, 1990.
24. IN 2004-05, "Spent Fuel Pool Leakage to Onsite Groundwater," March 3, 2004.
25. IN 2006-13, "Ground-Water Contamination Due to Undetected Leakage of Radioactive," July 10, 2006.
26. IN Notice 2012-05, "Abnormal Releases of Radioactive Water Potentially Resulting in Groundwater Contamination," April 25, 2012.
27. NEI 07-09A, "Generic FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description," Revision 0, March 2009.
28. NEI 08-08A, "Generic FSAR Template Guidance for Life Cycle Minimization of Contamination," Revision 0, October 2009.
29. NEI 97-06, "Steam Generator Program Guidelines," 1997.
30. NUREG-0800, Section 5, Branch Technical Position (BTP) 5-1 "Monitoring of Secondary Side Water Chemistry in PWR Steam Generators."
31. NUREG-0800, Section 11.2, BTP 11-6, "Postulated Radioactive Releases Due to Liquid-Containing Tank Failures," as revised by DC/COL-ISG-013.
32. NUREG-0933, "Resolution of Generic Safety Issues (Formerly entitled "A Prioritization of Generic Safety Issues," December 2011.
33. NUREG-1430, "Standard Technical Specifications — Babcock and Wilcox Plants."
34. NUREG-1431, "Standard Technical Specifications — Westinghouse Plants."
35. NUREG-1432, "Standard Technical Specifications — Combustion Engineering Plants."
36. NUREG-1433, "Standard Technical Specifications — General Electric Plants (BWR/4)."
37. NUREG-1434, "Standard Technical Specifications — General Electric Plants (BWR/6)."
38. NUREG/CR-4601, "Technical Considerations Affecting Preparation of Ion Exchange Resins for Disposal," May 1, 1986.
39. RG 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning."

40. RG 1.54, "Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants."
41. RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants."
42. RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."
43. RG 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants."
44. 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."
45. RG 1.187, "Guidance for Implementation of 10 CFR 50.59 Changes, Tests, and Experiments."
46. RG 1.189, "Fire Protection for Nuclear Power Plants."
47. RG 1.205, Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants.
48. RG 1.215, "Guidance for ITAAC Closure under 10 CFR Part 52."
49. RG 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable."
50. RG 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable."
51. RIS 2008-03, "Return/Re-use of Previously Discharged Radioactive Effluents," February 13, 2008.