U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD for NuScale SMR DESIGN

11.2 LIQUID WASTE MANAGEMENT SYSTEM

REVIEW RESPONSIBILITIES

Primary - Organization responsible for review of effectiveness of radwaste systems and health physics.

Secondary - Organization responsible for review of radwaste system design and performance.

I. AREAS OF REVIEW

The small modular reactor (SMR) liquid waste management system (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 regulations of the U.S. Nuclear Regulatory Commission (NRC). Review of the LWMS includes design features that are necessary for collecting, handling, processing, releasing, storing, and disposing of liquid effluents. This review encompasses, but is not limited to tanks, piping, pumps, valves, filters, deminferalizers, 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 SMR LWMS has been categorized as nonsafety-related and non-risk-significant. Failure of the LWMS should not compromise any safety-related system or component, nor should it prevent the safe shutdown of the plant. However, the failure of specific systems or components may have some impacts on the means to control and monitor liquid effluent releases and in complying with NRC regulations. The applicant's final safety analysis report (FSAR) must provide sufficient information to confirm that any failure of essential systems meets these criteria. The LWMS is relied on to control releases of radioactive materials in liquid effluents to the environment; therefore, having a direct impact on public health and safety. 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 review of the LWMS includes the design, design objectives, design criteria, methods of treatment, system interfaces, bypass routes to non-radioactive 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) showing methods of operation that influence waste treatment.

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The design-specific review standard (DSRS) includes 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 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 systems 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 in accordance with the guidance of Regulatory Guide (RG) 1.143 for liquids and liquid wastes produced during normal operation and AOOs.

5. Quality assurance provisions for radioactive waste management systems, structures and components in support of design criteria in accordance with the guidance 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 and radwaste buidlings, if part of the design, 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 systems.

7. With respect to the immersion of the reactor module in the reactor pool, the review will address production mechanism and concentration of neutron activation products in reactor pool water. In a parallel concern, the review will address whether neutron activation of the secondary coolant is possible given the close proximity of feedwater nozzle plenums to the top of the reactor core.

8. 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.

9. Design provisions to preclude placing components and structures of system components under adverse vacuum conditions.

10. Provisions incorporated in equipment and facility design to reduce leakage and facilitate operation and maintenance in accordance with the guidance of RG 1.143 for liquids and liquid wastes produced during normal operation and AOOs.

11. 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 guidance of RG 4.21 and NUREG/CR-3587 and industry standards.

12. Special design features to reduce leakage of liquid waste or discharges of radioactive materials to avoid uncontrolled and unmonitored releases to the environment under IE Bulletin 80-10 and RG 4.21.

13. Design features and applications of surface protective coatings on concrete floor surfaces in areas where process equipment are located and exposed surfaces in sumps and drain channels using the guidance of RG 1.54 in facilitating the decontamination of radioactivity.

14. 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 systems using the guidance of DSRS Sections 11.3 and 11.5, SRP Sections 9.4.1, 9.4.2, 9.4.3, and RGs 1.140 and 1.143.

15. Designs features of structure and component 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.

16. For processing systems 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.

17. Special design features, topical reports incorporated by reference, and data obtained from previous experience with similar systems as described in the FSAR or other supporting documents (e.g., FSAR of operating plants) in support of the design basis.

18. 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 systems.

19. Types and characteristics of filtration, ion-exchange resins, and adsorbent media to treat liquid process and effluent streams, including expected removal efficiencies, decontamination factors, and holdup or decay times and their applications by specific waste streams. The information describing types of proposed filtration and adsorption media should include details from suppliers, as generic or plant-specific information.

20. 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 SWMS components.

21. 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 in accordance with the guidance of RG 1.143 for liquid wastes and liquid effluents produced during normal operation and AOOs.

22. 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 Title 10 of the *Code of Federal Regulations* (CFR), Section 20.1406. The 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.

23. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this DSRS section in accordance with Standard Review Plan (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 DSRS section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with applicable sections of SRP Section 14.3 and RG 1.215.

24. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters). 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, and confirm the adequacy of proposed ITAAC and methods used in verifying that all interface requirements would be met by a COL applicant under 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).

25. For a COL application referencing a DC. When referencing a DC, a COL applicant must address COL action items, requirements, and restrictions 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 Part 52 process for seeking exemptions, changes, and departures is observed in changing Tier 1, Tier 2, and Tier 2* information.

26. Early Site Permit (ESP) Applications that reference the NuScale standard reactor design. For an ESP application, submitted under 10 CFR Part 52, Subpart A, the review

is limited to the information on potential radiological exposures to members of the public from liquid effluents that would be generated as a normal byproduct of nuclear power plant operations. The estimates on the maximum doses to the public should be based on the bounding liquid radiological effluents used in assessing potential exposures on the public by considering the probable pathways to individuals and populations near the proposed new unit(s) for all expected activities. 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. 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 of the site that could affect the design basis of LWMS SSCs (in the context of DSRS Section 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.

Review Interfaces

Systems described in the technical submittal may differ from those outlined in the DSRS or SRP. The staff should use the following recommended DSRS or SRP section interfaces as the basis for reviewing supplemental or complementary information provided in the FSAR for a specific plant design. Other DSRS or 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 under DSRS Section 11.5.

2. The reviews of interfaces with certified standard designs and ESPs, COL information items, and conformance with regulatory guidance (RG, SECY, RIS, bulletins, notices, and generic letters) are described in SRP Section 1.0.

3. The review of the definition of the exclusion area boundary and administrative controls in managing liquid effluent releases is performed in SRP Section 2.1.2 and DSRS Section 11.5.

   The review of the impacts of an accidental release of radioactive liquids in ground or surface water and effects on existing users or likely future users of ground or surface water resources is performed under SRP Section 2.4.13 and information and guidance from DSRS Section 11.2 and SRP Branch Technical Position (BTP) 11-6.

4. The review or conduct of independent source term calculations for the purpose of assessing the performance of the LWMS against the NRC requirements of 10 CFR 20.1301 and 20.1302; Table 2, Column 2 and Note 4 unity criterion of Appendix B to 10 CFR Part 20; and design objectives of Appendix I to 10 CFR Part 50, is performed under DSRS Section 11.1 using RG 1.112 and NUREG-0017, as modified to reflect the design features ofSMRs.

5. 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 reviewed in DSRS Section 11.5, and SRP Sections 13.4.

6. 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 under DSRS Sections 3.7.1 through 3.7.3, 3.8.4, 3.8.5, SRP Sections 3.3.1, 3.3.2, 3.4.2, 3.5.3, 3.7.4; and natural phenomena and man-induced hazards listed in RG 1.143 in assigning safety classifications to SSCs for the LWMS.

7. The review of the acceptability of the seismic and quality group classifications for system and components is performed under SRP Sections 3.2.1 and 3.2.2.

8. The review of interfaces 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, and system pressure, flow rate, and temperature), is performed using the guidance presented in DSRS Sections 11.5, 11.6 and SRP Section 9.3.2. The review addresses the types and placement of such sensors in plant systems, operational ranges and qualification of sensing elements in supporting the functions of radiation monitoring instrumentation, functional interdependence and logic in alarming and terminating or diverting process or effluent streams in complying with doses for members of the public and effluent concentration limits under 10 CFR Part 20, before exceeding design objectives of Appendix I to 10 CFR Part 50, in preventing radioactive contamination of otherwise non-radioactive plant systems, and in avoiding unmonitored and uncontrolled releases of radioactive materials in the environment.

9. The review of the interface of the LWMS with the 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 non-radioactive systems and avoid unmonitored and uncontrolled releases to the environment.

10. The review of the interface of the LWMS with process fluids collected by equipment and floor drains is performed in DSRS Sections 9.1.3, 9.3.4, 9.3.6, and SRP Sections 9.2.2, 9.2.6, 9.3.2, 9.3.3, 10.4.6, and 10.4.8.

11. The review of the interface of the LWMS with primary and secondary coolant systems as they relate to features provided to limit leakage rates or reduce the buildup of radioactivity in tanks, heat exchangers, steam generators, and other components is performed in DSRS Sections 5.2.5, 5.4.2.1, 5.4.2.2, 5.4.7, 6.2.2, 6.2.4, 11.5 and 12.3-12.4; SRP 5.4.12; and BTP 5-1 as they relate to the sensitivity of installed radioactivity detectors in complying with Nuclear Energy Institute (NEI) 97-06 and applicable Electric Power Research Institute (EPRI) guidelines, as described in DSRS Section 12.3-12.4.

12. The review of the interface of the LWMS discharge path with the circulating water system and plant blowdown to unrestricted areas, as site-specific balance of plant design features, is performed in DSRS Section 10.4.7 and SRP Sections 10.4.1, 10.4.2, 10.4.3, 10.4.4, 10.4.5, and 10.4.6.

13. The review of applicable technical specifications (TS) is performed under DSRS Sections 16.0 and 11.5, as they relate to administrative programs on radioactive effluent controls and monitoring.

14. The review of quality assurance is performed under SRP Chapter 17.5 and RG 1.143 for systems not covered by Part 50, Appendix B requirements with the supporting information provided in DSRS Sections 11.2 to 11.6, as applicable.

15. 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 under SRP Sections 9.5.1.1, 9.5.1.2 and DSRS Section 11.4 using RG 1.189 as it relates to the conduct of fire hazards analysis involving the presence of radioactivity in combustible or inflammable materials.

16. For any portion of the LWMS post-accident systems that supports safety-related functions, as identified by the applicant, the review of these design features is performed under DSRS Chapter 7 and DSRS Section 11.6 and SRP Section 13.3. In this context, the review, using RG 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.

17. 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 under DSRS Section 11.3 and SRP Sections 9.4.1, 9.4.2, and 9.4.4. DSRS 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.

18. The review of design features for the protection of potable and sanitary water systems is performed under SRP Section 9.2.4 and DSRS Section 11.5, as they relate to system interfaces in avoiding potential bypass routes to non-radioactive systems.

19. The review of design features of the LWMS attributed for compliance with 10 CFR 20.1406, using the guidance of RG 4.21, is performed in DSRS Section 12.3–12.4.

20. The review of design features with the means to return samples collected from process and effluents streams to their origins, and prevent sampled streams from being discharged locally or released to the environment without being monitored is conducted in DSRS Sections 11.5 and 11.6.

21. The review of design features to purge and flush sampling lines and monitors with non-radioactive fluids (e.g., clean water, air, inert gases) and route purged or flushed fluids to the most appropriate systems (LWMS and GWMS) is conducted in DSRS Sections 11.5 and 11.6. The review should confirm that the source of non-radioactive purging or flushing fluids is protected from backflow and cross-contamination using appropriate measures, such as check valves, backflow preventers, interlocks, differential pressures, etc.

22. 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 RGs 8.8 and 8.10 is performed in DSRS Section 12.5.

23. The review of design features of LWMS systems and components associated with the plant's initial testing plan, description of tests, and testing acceptance criteria is performed in DSRS Sections 14.2, 11.5, and 11.6, and SRP 9.3.2 using RG 1.68.

24. The completeness of the description of the LWMS design and its operational features are reviewed in SRP Section 14.3.7 to ensure that there is sufficient information in Tier 1, Tier 2, and Tier 2* 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 Commission regulations:

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 as low as is reasonably achievable (ALARA).

2. 10 CFR 20.1301, 10 CFR 20.1302, and Table 2, Column 2 and Note 4 unity criterion 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(a) and (b), 10 CFR 52.47(a)(5), and 10 CFR 52.79(a)(3), and 10 CFR 52.79(a)(1)(i) and (ii),, 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 50.34a, 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.

6. 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.

7. Appendix B to 10 CFR Part 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," in so far as it applies to LWMS systems and components not covered by the quality assurance (QA) guidance of RG 1.143.

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 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.

9. Appendix A to 10 CFR Part 50, GDC 3, as it relates to the design of LWMS systems and components 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 RG 1.189 as it relates to the conduct of fire hazards analysis involving the presence of radioactivity in combustible or inflammable materials.

10. Appendix A to 10 CFR Part 50, GDC 60, as it relates to the ability of the LWMS design to control releases of radioactive materials to the environment.

11. Appendix A to 10 CFR Part 50, GDC 61, as it relates to the ability of the LWMS design to ensure adequate safety under normal and postulated accident conditions, as described in SRP Section 2.4.13, DSRS Section 11.2, Branch Technical Position (BTP) 11-6 and analysis of RG 1.143 in assigning the safety classifications to LWMS SSCs for design purposes.

12. Appendix I to 10 CFR Part 50, Sections II.A and II.D, as they relate to the numerical criteria for design objectives and limiting conditions for operation to meet the ”as low as is reasonably achievable” criterion.

13. 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). DSRS Sections 11.3 and 11.4 evaluate source terms and doses from gaseous effluents and solid wastes. In turn, DSRS Section 11.5 addresses the means to demonstrate compliance with all sources of effluents. DSRS Section 12.3-12.4 evaluates doses associated with external radiation from buildings and sources of radioactivity contained in systems and components, including dose contributions from radwaste storage facilities.

14. 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 met, a facility that incorporates the DC has been constructed and will be operated in conformity with the DC, the provisions of the Atomic Energy Act (AEA), and the NRC's rules and regulations.

15. 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 met, the facility has been constructed and will operate in conformity with the COL, the provisions of the AEA, and the NRC's rules and regulations.

16. 10 CFR 52.17(a)(1)(ii), for an ESP application, the relevant requirement is limited to 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.

DSRS Acceptance Criteria

Specific DSRS acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are set forth below. The DSRS is not a substitute for the NRC's regulations, and compliance with it is not required. Identifying the differences between this DSRS section and the design features, analytical techniques, and procedural measures proposed for the facility, and discussing how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria, is sufficient to meet the intent of 10 CFR 52.47(a)(9), "Contents of applications; technical information." The same approach may be used to meet the requirements of 10 CFR 52.79(a)(41) for COL applications.

1. The LWMS should have the capability to meet the dose design objectives 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. RGs 1.109, 1.112, and 1.113 and the LADTAP II computer code (NUREG/CR-4013) 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. RG 1.110 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 unity criterion of Appendix B, to 10 CFR Part 20.

   D. With respect to the immersion of the reactor module in the reactor pool, the review will address production mechanism and concentration of neutron activation products in reactor pool water. In a parallel concern, the review will address whether neutron activation of the secondary coolant is possible given the close proximity of feedwater nozzle plenums to the top of the reactor core. In either case, the review will consider reactions associated with thermal and fast neutrons, expected neutron flux density in zones enveloping each reactor vessel, target elements present in reactor pool water, and equilibrium concentrations of activated radionuclides and their decay chain products. The presence of neutron activation products should reflect target elements present in demineralized water and inadvertent introduction of impurities into pool water and secondary coolant during maintenance, refueling operations, and component failures, e.g., resin

breakthrough out of resin traps. For longer-lived activation products, the review will consider whether the design includes processing equipment, such as liquid and gaseous waste management systems, that will be used to reduce their concentrations in reactor pool water and ambient atmosphere of the reactor building. In characterizing the associated source terms (pool water and secondary coolant), the review will assess whether the applicant has considered the presence of radionuclides other than those listed in NUREG-0017 and PWR-GALE86 or in ANSI/ANS 18.1-1999.

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 systems, 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 guidance 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. For the purpose of this DSRS, the dose limit cited in Section 5 of RG 1.143, addressing unmitigated releases of radioactive materials, is revised to be consistent with that of 10 CFR 20.1301. The annual dose limit of 10 CFR 20.1301 is 100 mrem (1 mSv) 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 dose limit is 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, Part I, C.I.3, SRP Sections 3.2.1 and 3.2.2 and DSRS 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.

4. The LWMS should be designed to implement the requirements of 10 CFR 20.1406. System designs should contain provisions to control leakage and facilitate operation and maintenance in accordance with the guidance of RGs 1.33, 1.143 and 4.21 and industry standards cited in these RGs 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 guidance of Interim Staff Guidance (ISG) DC/COL-ISG-06, RG 4.21, and NEI 08-08A, for liquids and liquid wastes produced during normal operation and AOOs.

5. For processing systems equipped with automatic control features, the design should provide the 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. Acceptable guidance is presented in DSRS Section 11.5 and ANS N42.18-2004.

6. The design of exhaust ventilation systems used to collect and vent radioactive gases and vapors from tanks, vessels, and processing equipment should use the guidance of DSRS Sections 11.3 and 11.5, SRP Sections 9.4.1, 9.4.2, and 9.4.4, 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.

7. 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 RGs, ISG and BTP are 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 design objectives and ALARA provisions.

2. RG 1.112, as it relates to the use of acceptable methods for calculating annual average releases of radioactive materials in liquid effluents.

3. RG 1.110, as it relates to performing a cost benefit analysis for reducing cumulative dose to the population by using available effluent treatment technologies.

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 design objectives.

5. RG 1.143, as it relates to quality assurance provisions for radioactive waste management systems, structures and components in so far as it applies to LWMS systems 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 leakages of liquids and liquid wastes produced during normal operation and 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-06, NEI 08-08A, and RG 4.21, as they relate to acceptable levels of detail and content needed to demonstrate compliance with 10 CFR 20.1406.

9. DC/COL-ISG-013, "Interim Staff Guidance on NUREG-0800, Standard Review Plan Section 11.2 and BTP 11-6, Assessing the Consequences of an Accidental Release of Radioactive Materials from Liquid Waste Tanks for Combined License Applications Submitted under 10 CFR Part 52," Revision 0, as incorporated in BTP 11-6.

10. 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 the reactor and radwaste buildings, and impacts of the release of radioactive materials into the nearest existing or a 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.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this DSRS 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 one of these approaches using A and B below:

   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 unity criterion of Appendix B to 10 CFR Part 20, and

   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 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 in this DSRS section. Meeting the requirements on gaseous effluent concentration limits in unrestricted areas is identified as an acceptance criterion in DSRS Section 11.3 and will be evaluated in that DSRS 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/COM-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 DSRS Section 12.3-12.4.

3. Acceptance Criterion II.5 gives the technical rationale for 10 CFR 50.34a requirements.

   Meeting the requirements of 10 CFR 50.34a, as it relates 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, 10 CFR 20.1301(e); and Appendix I to 10 CFR Part 50; and GDCs 60 and 61.

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 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 results in doses caused by releases of radioactive materials from each reactor comply with 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.

   Meeting the requirements of Sections II.A and II.D 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 specified in Section II.A and the acceptance criterion for cost-benefit analysis specified in Section II.D for meeting the ALARA objective 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 solid wastes produced during normal reactor operation, including AOOs.

   GDC 60 specifies 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 also provides 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 NUREG-0017 and RG 1.112, as modified to reflect the design features of SMRs.

   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 of ion-exchange resin column or activated charcoal bed, types and volumes of ion-exchange resins or activated

charcoals, removal efficiencies and decontamination factors taking into account the expected physical, chemical, processing flow rates, and radiological properties of liquid process and effluent streams. The review should determine whether performance meets or exceeds that noted in NRC guidance NUREG-0017 (as modified), 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.

With respect to the immersion of the reactor module in the reactor pool, the review will address production mechanism and concentration of neutron activation products in reactor pool water. In a parallel concern, the review will address whether neutron activation of the secondary coolant is possible given the close proximity of feedwater nozzle plenums to the top of the reactor core. In either case, the review will consider reactions associated with thermal and fast neutrons, expected neutron flux density in zones enveloping each reactor vessel, target elements present in reactor pool water, and equilibrium concentrations of activated radionuclides and their decay chain products. The presence of neutron activation products should reflect target elements present in demineralized water and inadvertent introduction of impurities into pool water and secondary coolant during maintenance, refueling operations, and component failures, e.g., resin breakthrough out of resin traps. For longer-lived activation products, the review will consider whether the design includes processing equipment, such as liquid and gaseous waste management systems, that will be used to reduce their concentrations in reactor pool water and ambient atmosphere of the reactor building. In characterizing the associated source terms (pool water and secondary coolant), the review will assess whether the applicant has considered the presence of radionuclides other than those listed in NUREG-0017 and PWR-GALE86 or in ANSI/ANS 18.1-1999.

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 design 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 unity criterion 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 as part design considerations of exhaust ventilation and treatment systems under the guidance of DSRS Sections 9.4.1, 9.4.2, and 9.4.4, 11.3, and 11.5, RG 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 guidance also address radiation monitoring instrumentation 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 quality assurance provisions for the systems, structures, and components of the LWMS 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. For the purpose of this DSRS, the dose limit cited in Section 5 of RG 1.143, addressing unmitigated releases of radioactive materials, is revised to be consistent with that of 10 CFR 20.1301. The annual dose limit of 10 CFR 20.1301 is 100 mrem (1 mSv) 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 dose limit 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 criteria in determining the appropriate safety classification. In addition, RG 1.206, Part I, C.I.3, SRP Sections 3.2.1 and 3.2.2 and DSRS 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 doses that exceed the limits specified in 10 CFR Part 20. In addition, meeting this requirement will help ensure that the LWMS will continue to perform its function(s) under postulated accident conditions.

Compliance with 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 RG 1.143 for natural phenomena and man-induced hazards. Meeting the requirements of GDC 2 and 61 provides reasonable assurance that the necessary information is available to identify the amounts of radioactive materials contained in LWMS and assess the radiological impacts during postulated accidents, as described in SRP Section 2.4.13, DSRS Section11.2 and BTP 11-6, and analysis of RG 1.143 in assigning the safety classifications to SSCs of the LWMS for design purposes.

7. GDC 3 requires that SSCs important to safety shall be designed and located, consistent with other safety requirements, to minimize the probability and effect of fires and explosions. With respect to the LWMS, GDC 3 relates to 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.

   Meeting the requirements of GDC 3 provides assurance that the LWMS is protected from the effects of explosive mixtures and exothermic reactions and that the functions of its systems and components will not be compromised in meeting the effluent discharge concentration limits of 10 CFR Part 20. Specific NRC guidance is provided in RG 1.189, IE Information Notices 83-14, 84-72, 88-08, and 90-50, and in NUREG/CR-4601.

8. The acceptance criteria require that an applicant evaluates the consequences of the release of radioactive liquids following the postulated failure of a tank and its

components, located outside of the reactor and radwaste buildings, and impacts of radioactive materials at the nearest water supply (surface 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 the design bases as required by 10 CFR Part 50.34a, and GDCs 60 and 61 of Appendix A to Part 50.

BTP 11-6 presents guidance and a graded approach in assessing the radiological impacts. 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 demonstrate conformance BTP 11-6 acceptance criteria, the applicant is expected to propose TS limiting the total amount of radioactivity in such a tank and components in accordance with DSRS Chapter 16, Section 5.5, Programs and Manuals.

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, and radioactive waste storage areas. The EPA standards apply to the entire site or facility, whether it has single or multiple reactor units. DSRS Sections 11.3 and 11.4 address the sources of radioactivity and doses associated with gaseous effluents and solid wastes, respectively. DSRS Section 12.3-12.4 addresses the sources of radiation and external radiation exposures from buildings, storage tanks, and radioactive waste storage areas.

   For 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. If there is no site-specific information, the applicant may assume 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 by appropriately assigning doses with actual exposure pathways once site-specific information becomes available on their locations within the vicinity of the site.

III. REVIEW PROCEDURES

These review procedures are based on the identified DSRS 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 DSRS acceptance criteria and supporting regulatory guidance.

While the LWMS has been categorized as non-safety-related and non-risk-significant, the failure of specific systems or components may have some impacts on the means to control and monitor liquid effluent releases and in complying with NRC regulations under 10 CFR Part 20 and Part 50, Appendix I. As such, the review of the LWMS requires a more detailed review than other non-safety-related and non-risk significant systems given its direct impact on public health and safety. The staff will evaluate whether the failure of a LWMS subsystem would compromise any safety-related system or component, or prevent the safe shutdown of the plant. The applicant's FSAR will be reviewed to confirm that sufficient information has been provided in the FSAR, including assumptions, results, and conclusions of the failure analysis, in confirming that the failure of essential systems will not result in plant or operating conditions being in non-compliance with NRC regulations, including radioactive effluent releases, exposures to radiation and radioactive materials, and doses to workers and members of the public.

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 9.3.1, 9.3.2, 9.3.3, 10.4.1, 10.4.2, 10.4.3, 10.4.4, 10.4.5, 10.4.6, 10.4.8, DSRS Sections 9.3.4, 10.4.7, 11.1, 11.3, 11.4, 11.5, 11.6, and 12.3-12.4, for completeness in accordance with RG 1.70, RG 1.206, and DC/COL-ISG-06 as incorporated in DSRS Section 12.3 -12.4.

1. Selected Programs and Guidance—In accordance with the guidance in NUREG–0800, "Introduction – Part 2: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: Light-Water Small Modular Reactor Edition" (NUREG-0800, Intro Part 2), as applied to this DSRS Section, the staff will review the information proposed by the applicant to evaluate whether it meets the acceptance criteria described in Subsection II of this DSRS. As noted in NUREG-0800, Intro Part 2, the NRC requirements that must be met by an SSC do not change under the small modular reactor (SMR) framework. Using the graded approach described in NUREG-0800, Intro Part 2, the NRC staff may determine that, for certain SSCs, the applicant's basis for compliance with other selected NRC requirements may help demonstrate satisfaction of the applicable acceptance criteria for that SSC in lieu of detailed independent analyses. The design-basis capabilities of specific SSCs would be verified, where applicable, as part of completing the applicable ITAAC. The use of the selected programs to augment or replace traditional review procedures is shown in Figure 1 of NUREG-0800, Intro Part 2. Examples of such programs that may be relevant to the graded approach for these SSCs include:

- 10 CFR Part 50, Appendix A, GDC, Overall Requirements, Criteria 1–5
- 10 CFR Part 50, Appendix B, Quality Assurance (QA) Program
- 10 CFR 50.49, Environmental Qualification of Electrical Equipment (EQ) Program
- 10 CFR 50.55a, Code Design, Inservice Inspection, and Inservice Testing (ISI/IST) Programs

- 10 CFR 50.65, Maintenance Rule requirements
- Reliability Assurance Program (RAP)
- 10 CFR 50.36, “Technical Specifications”
- Availability Controls for SSCs Subject to Regulatory Treatment of Nonsafety Systems (RTNSS)
- Initial Test Program (ITP)
- Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)

2. This list of examples is not intended to be all inclusive. It is the responsibility of the technical reviewers to determine whether the information in the application, including the degree to which the applicant seeks to rely on such selected programs and guidance, demonstrates that all acceptance criteria have been met to support the safety finding for a particular SSC.In accordance with 10 CFR 52.47(a)(8), (21), and (22), and 10 CFR 52.79(a)(17), (20), and (37), for DC or COL 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 generic safety issues which are identified in the version of NUREG-0933, “Resolution of Generic Safety Issues,” current on the date up to 6 months before the docket date of the application and which are technically relevant to the design, (2) demonstrate how the operating experience insights have been incorporated into the plant design, and (3) provide information necessary to demonstrate compliance with any technically relevant portions of the Three Mile Island requirements set forth in 10 CFR 50.34(f), except paragraphs (f)(1)(xii), (f)(2)(ix), and (f)(3)(v), for a DC application, and except paragraphs (f)(1)(xii), (f)(2)(ix), (f)(2)(xxv), and (f)(3)(v),for a COL application. These cross-cutting review areas should be addressed by the reviewer for each technical subsection and relevant conclusions documented in the corresponding safety evaluation report (SER) section.

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 non-radioactive 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 PWR-GALE86 Code, and calculation techniques referred to in NUREG-0017 and RG 1.112, as modified to reflecting design-specific features of the proposed reactor technology. The applicant should document the basis of differences, with sufficient supporting information included in the application, to allow the staff to conduct an independent evaluation of the applicant’s use of alternate code parameters. 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 method in estimating yearly releases of radioactive materials in liquid effluents in demonstrating compliance with DSRS acceptance criteria and regulatory guidance. The result of this calculation will be used to determine whether the proposed treatment system design meets the acceptance criteria of DSRS Subsection II, Acceptance Criteria, Subsection 1.C of this and relevant sections of DSRS Section 11.1.

Compliance with the acceptance criteria given in this DSRS, Section II, Acceptance Criteria, Subsection 1.A 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 methods referred to in NUREG-0017 and RG 1.112 (as modified) and RG 1.113, and NUREG/CR-4013 (LADTAP II Code). If neutron activation products are expected in reactor pool water and secondary coolant, the applicant should document the basis for the presence of additional radionuclides, other than those listed in in NUREG-0017 and PWR-GALE86 or in ANSI/ANS 18.1-1999, and provide sufficient information for the staff to conduct an independent evaluation.

Compliance with the acceptance criterion given in this DSRS, Section II, Acceptance Criteria, Subsection 1.B 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. 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 wastes at design-basis source term levels. Source terms are evaluated based on information presented in DSRS Section 11.1 and in this DSRS section. The source term is based on a combination of assumptions of failed fuel fractions (e.g., 0.25 to 1 percent) for PWRs, or the reactor coolant system isotopic concentrations, including fission products and significant corrosion and activation products, equivalent to operation for a full fuel cycle at the technical specification limits for halogens (I-131 dose equivalent) and noble gases (Xe-133 dose equivalent), and steam generator technical specification limits on primary to secondary leakage rates. If different assumptions are used, applicants should document the basis for any adjustment used in the PWR-GALE86 code to allow the staff to conduct an independent evaluation of the applicant's use of alternate code parameters, given sufficient information.

   D. Types and characteristics of filtration systems, ion-exchange resins, and adsorbent media (activated charcoal), electro-deionization and reverse osmosis units, and use of other treatment technologies to delist specific chemical properties, as described in the application, to treat process and effluent streams, with removal efficiencies, decontamination factors, and holdup times for meeting or exceeding the performance of RG 1.112 (and generic guidance of NUREG-

0017, as modified to reflect the design features of SMRs). The above information may be drawn from standard DCs, or topical reports, taking into account the expected processing flow rates and volumes, physical, chemical, and radiological properties of liquid process and effluent streams. If neutron activation products are expected in reactor pool water and secondary coolant, the presence of such activation products should reflect target elements present in demineralized water and inadvertent introduction of impurities into pool water and secondary coolant during maintenance, refueling operations, and component failures, e.g., resin breakthrough out of resin traps. In this context, the evaluation should consider whether the degradation of pool impurities, via neutron activation, might affect the effectiveness of waste treatment systems (as reduced DFs and removal efficiencies) and introduce chemical species into the pool and its cleanup systems with the potential of impacting the mechanical intregrity of such systems and components.

E. Justification for automatic control to features and 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 in terminating releases or isolating process flows when deviations exceed preset limits. Acceptable guidance is presented in DSRS Section 11.5 and ANS N42.18-2004.

F. The average input flow rates and volumes are compared with the design flows to determine the fraction of time individual systems must be online to process normal waste inputs. The review considers the operational flexibility designed into the system (i.e., cross-connections between systems, redundant or reserve processing equipment, and 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 flows with the potential process routes and equipment capacities.

G. It will be assumed that the primary means for processing liquid waste is unavailable for 2 consecutive days per week for maintenance. If 2 days of 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 guidance referred to in NUREG-0017 and RG 1.112, as modified to reflect the design features of SMRs. If the alternate method includes the use of mobile processing systems connected to permanently installed LWMS systems, the staff will conduct a parallel review and evaluation of such a method using the above guidance and acceptance criteria.

H. Given the immersion of each reactor module in the reactor pool, the review will address the preparation and transfer of each reactor module to the refueling pool, the review should consider design features that will isolate any open portions of the primary and secondary coolant systems in minimizing the contamination of reactor pool water and ambient atmosphere within the reactor building. In minimizing the transfer of contamination, the description of design features should specify which ones are part of the design, those that are

temporary and would be installed to reactor vessel components before each transfer, and necessary interfaces with liquid and gaseous waste management systems.

I. Given that the design does not include a Steam Generator (SG) blowdown and treatment system, the review will consider the capability of the condensate polishing demineralizers to remove fission products (except for Noble Gases (NG) and other volatile products) from the secondary side in the event of SG tube failures. The review will evaluate design features to collect main condenser evacuation system (MCES) and turbine gland sealing system (TGSS) condensate equipment drains and exhausts for processing and monitoring, transfer and collection of spent resins for processing, packaging, and storage, and collect and route turbine building floor and equipment drains to the radwaste building or waste a handling facility located within the turbine building for all condenser/turbine modules. The review will consider necessary interfaces with liquid and gaseous waste management systems, decay heat removal system heat exchangers, feedwater condensate storage tanks, and radiation monitoring instrumentation in avoiding uncontrolled and unmonitored releases to the environment and cross-contamination of non-radioactive systems. NRC requirements and NRC and industry guidance are provided in Part 20.1406, SRP Section 10.4.8, DSRS Sections 5.4.2.1, 5.4.2.2, 11.2, 11.3, 11.5, 11.6, and 12.3-12.4, and Branch Technical Position (BTP) 5-1 (Monitoring of Secondary Side Water Chemistry in Pressurized Water Reactor (PWR) Steam Generators), Regulatory Guide 4.2, and NEI 08-08A.

5. The quality group and safety classifications of piping and equipment within the LWMS are compared to the guidance of RG 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, DSRS 3.7.1 through 3.7.3, 3.8.4, 3.8.5 and SRP Sections 3.2.1, 3.2.2, 3.3.1, 3.3.2, 3.5.3, 3.7.4 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 meet 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, depending on the concentration of radioactive materials and leak/spill rates (e.g., several gallons per week).

C. Design features should be 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 and 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.

E. Design features that facilitate decommissioning should be described, and their role in the decommissioning process should be discussed. 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. The site and plant facilities have been designed and will be operated to minimize the generation and volume of radioactive waste, both during operation and during decommissioning.

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

A. DC/COL-ISG-06, as incorporated in DSRS Section 12.3-12.4.

B. RG 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. DSRS Sections 9.3.4, 10.4.7, SRP Sections 9.2.4, 9.3.2, 9.3.3, 10.4.1, 10.4.2, 10.4.3, 10.4.4, 10.4.5, 10.4.6, and 10.4.8.

D. IE Bulletin Nos. 80-05 and 80-10, and IE Circulars 81-09, 77-10, 77-14, 79-07, 79-09, 79-21, and 80-18; Information Notice 2004-05, 2006-13, and 2012-05; and Regulatory Issue Summary 2008-03.

E. Industry guidance and standards NEI 08-08A, ANS N42.18-2004, American Standard National Institute/American Nuclear Society (ANSI/ANS) 55.6-1993 (R2007), and ANSI/ANS-40.37-2009.

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 guidance 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 quality assurance provisions for the systems, structures, and components of the LWMS for liquids and liquid wastes produced during normal operation and AOOs. In assessing the radiological impact from unmitigated releases of radioactive materials or unmitigated exposures to site personnel and assigning safety classifications to structures, the acceptance criteria of RG 1.143 are 1 mSv (100 mrem) for an individual 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. For the purpose of this DSRS, the dose limit cited in Section 5 of RG 1.143, addressing unmitigated releases of radioactive materials, is revised to be consistent with that of 10 CFR 20.1301. The annual dose limit of 10 CFR 20.1301 is 100 mrem (1 mSv) for members of the public located in unrestricted areas. For this analysis, the radioactive source term is selected after conducting an inventory of the LWMS, with the maximum expected inventory of radioactive materials applied in the analysis. In classifying system components, the radioactivity inventories of components are compared to the acceptance criteria in determining the appropriate safety classification. RG 1.206, Part I, C.I.3, SRP Sections 3.2.1 and 3.2.2 and DSRS 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.

Compliance with RG 1.143 provides reasonable assurance that the assigned safety classifications for structures housing the LWMS and its components comply with the requirements of GDCs 2 and 61 for natural phenomena and man-induced hazards. Meeting the requirements of GDCs 2 and 61 provides reasonable assurance that the necessary information is available to identify the amounts of radioactive materials contained in LWMS and assess the radiological impacts during postulated accidents, as described in SRP Section 2.4.13, DSRS Section 11.2, BTP 11-6, and analysis of RG 1.143 in assigning the safety classifications to SSCs of the LWMS for design purposes.

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 DSRS Sections 11.5 and 16.0 and SRPs 13.4, 13.5.1.1, 13.5.1.2, 13.5.2.1, and 13.5.2.2. 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 Part 50.34a, 10 CFR 50.36a, using Generic Letter 89-01, and guidance contained in NUREG-1301 and NUREG-0133 for PWR designs. Alternatively, a COL applicant can endorse by reference NEI Template 07-09A, "Generic FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description," as the basis of the ODCM until a plant and site-specific ODCM is developed before fuel load in accordance with 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 impacts of such radioactive materials on the nearest point of entry into a usable water supply (surface 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 to water 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; process by which the radioactivity is assumed to be released in the environment from plant facilities; use of plant design features and credit assumed in mitigating the amounts of radioactivity released and duration of the release; 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 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 and groundwater. If the results of a plant and site-specific analysis do not demonstrate compliance with BTP 11-6 acceptance criteria, the applicant is expected to propose TS limiting the total amount of radioactivity in such tanks and components. 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 safety evaluation. The staff will confirm that DC/COL FSAR Chapter 16, Section 5.5, “Programs and Manuals,” identifies the requirements for this TS.

10. In determining compliance with the EPA generally applicable environmental radiation standards of 40 CFR Part 190, as implemented under 10 CFR Part 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 DSRS evaluates the source terms and associated doses from liquid effluents, while DSRS Sections 11.3 and 11.4 evaluate source terms and doses from gaseous effluents and solid wastes. In turn, DSRS Section 11.5 addresses the means in demonstrating compliance with all sources of effluents. DSRS Section 12.3 - 12.4 evaluates the doses associated with external radiation from buildings and sources of radioactivity contained in systems and components and dose contributions from radwaste storage facilities.

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. For COL applicants with site-specific information on the locations of offsite dose receptors, compliance with the EPA standards should provide the justification on the apportionment of doses due to liquid and gaseous effluent releases and external radiation 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.

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 during a COL application, they should be added to the 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 or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

    For reviews of both DC and COL applications, SRP Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of 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. Accordingly, the reviewer should ensure that plant design features of the certified design are maintained in the COL application and that, if requested, the Part 52 process for seeking exemptions, changes, and departures is observed in changing Tier 1, Tier 2, and Tier 2* information.

    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 conduct its evaluation of the associated SSCs, assess the adequacy of interface requirements with other SSCs that are included in the DC, 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) to 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 needed 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 (μCi/ml) are evaluated to determine

whether they are consistent with the requested thermal power level. 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 current revision of each DC and conservatively bounding over all expected radionuclides and estimate of releases.

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. 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 the early site permit at the COL stage. Accordingly, the reviewer should ensure that physical attributes of the site (in the context of DSRS Section 11.2) that could affect the design basis of LWMS SSCs important to safety are reflected in the site characteristics, design parameters, and conditions on 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 exposures 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. The COL action item would 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.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the staff's safety review and analysis, as augmented by the application of programmatic requirements in accordance with the staff's review approach described in the DSRS Introduction, support conclusions of the following types to be included in the staff's SER. The reviewer also states the basis for those conclusions.

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 appropriate GDC's 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 20.1101(b), 10 CFR 20.1301 and 20.1302, 10 CFR 20.1301(e), 10 CFR 20.1406; 10 CFR 50.34a and 10 CFR 50.36a; GDCs 2, 60 and 61;

and design objectives and ALARA provisions of Appendix I to 10 CFR Part 50. This conclusion is based on the following:

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 an LWMS 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, using the guidance of DSRS Section 11.1.

2. 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 at a cost of less than $1000 per man-rem or man-thyroid-rem.

3. The applicant has met the requirements of 10 CFR 20.1101(b), 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 being released to the primary and secondary coolant. The design basis fuel defect level is reviewed under the guidance of DSRS Section 11.1. 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 unity criterion 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 SMRs, as defined in the plant TS.

4. 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, as a source 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 presents the staff's evaluation of doses associated with external radiation from buildings and sources of radioactivity contained in systems and components and dose contributions from radwaste storage facilities.

5. 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. The staff concludes in that the proposed design features and operational programs and procedures are consistent with NRC guidance and the requirements of 10 CFR 20.1406.

6. The applicant has met the requirements of GDCs 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. The staff has reviewed the applicant's vacuum mitigating provisions for the LWMS and found these features to be in compliance with GDC 61 and consistent with the guidance of RG 1.143.

7. The applicant has met the requirements of GDCs 60 and 61 with respect to controlling releases of radioactive materials to the environment through the use of automatic control features in terminating liquid effluent discharges or diverting process flows to systems for storage and further processing, as needed.

8. 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 guidance of RG 1.143, for liquids and liquid wastes produced during normal operation and AOOs. The implementation 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 GDCs 2 and 61, and guidance of RG 1.143 for natural phenomena and man-induced hazards. Meeting the requirements of GDC 61 provides reasonable assurance that the necessary information and process were used to quantify the amounts of radioactive materials contained in LWMS and assess the radiological impacts during postulated accidents, using the guidance described in SRP Section 2.4.13 and DSRS Section 11.2 (BTP 11-6), and analysis of RG 1.143 in assigning the safety classifications to SSCs of the LWMS for design purposes.

9. 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 non-radioactive 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 are consistent with the requirements of GDCs 60 and 61 and guidance of RG 4.21 and RG 1.143 for liquids and liquid wastes produced during normal operation and AOOs.

10. 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 in FSAR 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, "Generic FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description." The staff has determined the endorsement of NEI ODCM Template 07-09A to be acceptable. The staff finds the commitment to use NEI ODCM Template 07-09A acceptable. The staff's evaluation of the ODCM is presented in SER Section 11.5.

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 the implementation of the guidance and acceptance criteria of SRP Sections 2.4.12 and 2.4.13, DSRS Section 11.2 and

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 guidance of BTP 11-6 and meets the acceptance criteria defined in BTP 11-6 for an offsite individual using the nearest source of usable water 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.

12. The staff has reviewed the provisions incorporated in the applicant's design to control releases from hydrogen explosions in the LWMS and concludes that the measures proposed by the applicant are adequate to prevent the occurrence of an explosion or to withstand the effects of an explosion, in accordance with GDC 3 and RG 1.189.

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 DSRS 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 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) to 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 the ITAAC, including design acceptance criteria, as applicable.

For an ESP application, the staff concludes that the applicant has provided an assessment that demonstrates its capability to comply with dose limits for members of the public under 10 CFR Part 20 and 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," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." The staff will confirm that the 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 applicant has identified this possibility and flagged it as consideration in a COL application. The COL action item flags 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 regulations in 10 CFR 52.17(a)(1)(xii), 10 CFR 52.47(a)(9), and 10 CFR 52.79(a)(41) establish requirements for applications for ESPs, DCs, and COLs, respectively. These regulations require the application to include an evaluation of the site (ESP), standard plant design (DC), or facility (COL) against the SRP revision in effect 6 months before the docket date of the application. While the SRP provides generic guidance, the staff developed the SRP guidance based on the staff's experience in reviewing applications for construction permits and operating licenses for large light-water nuclear power reactors. The proposed SMR designs, however, differ significantly from large light-water nuclear power plant designs.

In view of the differences between the designs of SMRs and the designs of large light-water power reactors, the Commission issued Staff Requirements Memorandum (SRM)-COMGBJ-10-0004/COMGEA-10-0001, "Use of Risk Insights To Enhance Safety Focus of Small Modular Reactor Reviews," dated August 31, 2010. In the SRM, the Commission directed the staff to develop risk-informed licensing review plans for each of the SMR design reviews, including plans for the associated preapplication activities. Accordingly, the staff has developed the content of the DSRS as an alternative method for evaluating a NuScale-specific application submitted pursuant to 10 CFR Part 52, and the staff has determined that each application may address the DSRS in lieu of addressing the SRP, with specified exceptions. These exceptions include particular review areas in which the DSRS directs reviewers to consult the SRP and others in which the SRP is used for the review. If an applicant chooses to address the DSRS, the application should identify and describe all differences between the design features (DC and COL applications only), analytical techniques, and procedural measures proposed in an application and the guidance of the applicable DSRS section (or SRP section, as specified in the DSRS), and discuss how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria.

The staff has accepted the content of the DSRS as an alternative method for evaluating whether an application complies with NRC regulations for NuScale SMR applications, provided that the application does not deviate significantly from the design and siting assumptions made by the NRC staff while preparing the DSRS. If the design or siting assumptions in a NuScale application deviate significantly from the design and siting assumptions the staff used in preparing the DSRS, the staff will use the more general guidance in the SRP, as specified in 10 CFR 52.17(a)(1)(xii), 10 CFR 52.47(a)(9), or 10 CFR 52.79(a)(41), depending on the type of application. Alternatively, the staff may supplement the DSRS section by adding appropriate criteria to address new design or siting assumptions.

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 Part 50, Appendix A, GDC 2, “Design bases for protection against natural phenomena.”

9. 10 CFR Part 50, Appendix A, GDC 3, “Fire protection.”

10. 10 CFR Part 50, Appendix A, GDC 60, “Control of releases of radioactive materials to the environment.”

11. 10 CFR Part 50, Appendix A, GDC 61, “Fuel storage and handling and radioactivity control.”

12. 10 CFR Part 50, Appendix B, “Quality assurance criteria for nuclear power plants and fuel reprocessing plants.”

13. 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.”

14. 10 CFR 52 Subpart A, “Early Site Permits.”

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. 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 DSRS Section 12.3-12.4.

20. DC/COL-ISG-013, “Interim Staff Guidance on NUREG-0800 Standard Review Plan Section 11.2 and Branch Technical Position 11-6, Assessing the Consequences of an Accidental Release of Radioactive Materials from Liquid Waste Tanks for Combined License Applications Submitted under 10 CFR Part 52,” Revision 0, as incorporated in BTP 11-6.

21. NUREG-0800, Section 11.2, BTP 11-6, “Postulated Radioactive Releases Due to Liquid-Containing Tank Failures.”

22. 40 CFR 190, “Environmental Radiation Protection Standards for Nuclear Power Operations.”

23. RG 1.11, “Instrument Lines Penetrating Primary Reactor Containment.”

24. RG 4.21, “Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning.”

25. RG 1.54, “Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants.”

26. RG 1.68, “Initial Test Programs for Water-Cooled Nuclear Power Plants.”

27. RG 1.70, “Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants.”

28. RG 1.97, “Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants.” For plant systems that are important to safety, see guidance in DSRS Section 11.6, “Guidance on Instrumentation and Control Design Features for Process and Effluent Radiological Monitoring, and Area Radiation and Airborne Radioactivity Monitoring.”

29. RG 1.110, “Cost Benefit Analysis for Radwaste Systems for Light Water Cooled Nuclear Power Reactors.”

30. 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.”

31. RG 1.112, “Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluent from Light-Water-Cooled Power Reactors.”

32. RG 1.113, “Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I.”

33. RG 1.33, “Quality Assurance Program Requirements (Operation).”

34. RG 1.140, “Design, Testing, and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light Water Cooled Nuclear Power Plants.”

35. RG 1.143, “Design Guidance for Radioactive Waste Management Systems, Structures and Components Installed in Light Water Cooled Nuclear Reactor Power Plants.”

36. RG 1.189, “Fire Protection for Nuclear Power Plants.”

37. RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition).”

38. RG 1.215, “Guidance for ITAAC Closure Under 10 CFR Part 52.”

39. RG 8.8, “Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable.”

40. RG 8.10, “Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable.”

41. NUREG-0133, “Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants.”

42. NUREG-1301, “Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors.”

43. NUREG/CR-4013, “LADTAP II - Technical Reference and User Guide.”

44. NUREG/CR-3587, “Identification and Evaluation of Facility Techniques for Decommissioning of Light Water Reactors.”

45. NUREG/CR-4601, “Technical Considerations Affecting Preparation of Ion Exchange Resins for Disposal,” May 1, 1986.

46. NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” March 2007.

47. 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.

48. IE Bulletin No. 80-10, “Contamination of Nonradioactive System and Resulting Potential for Unmonitored, Uncontrolled Release of Radioactivity to Environment,” May 6, 1980.

49. IE Circular No. 77-10, “Vacuum Conditions Resulting in Damage to Liquid Process Tanks,” July 15, 1977.

50. IE Circular No. 77-14, “Separation of Contaminated Water Systems from Uncontaminated Plant Systems,” November 22, 1977.

51. IE Circular No. 79-21, “Prevention of Unplanned Releases of Radioactivity,” October 17, 1979.

52. IE Circular No. 80-18, “10 CFR 50.59 Safety Evaluations for Changes to Radioactive Waste Treatment Systems,” August 22, 1980.

53. IE Circular No. 81-09, “Containment Effluent Water that Bypasses Radioactivity Monitor,” July 10, 1981.

54. IE Information Notice No. 79-07, “Rupture of Radwaste Tanks,” March 23, 1979.

55. IE Information Notice No. 79-09, “Spill of Radioactively Contaminated Resin,” March 30, 1979.

56. IE Information Notice No. 83-14, “Dewatered Spent Ion Exchange Resin Susceptibility to Exothermic Chemical Reaction,” March 21, 1983.

57. IE Information Notice No. 84-72, “Clarification of Conditions For Waste Shipments Subject To Hydrogen Gas Generation,” September 10, 1984.

58. IE Information Notice No. 88-08, “Chemical Reactions with Radioactive Waste Solidification Agents,” March 14, 1988.

59. Information Notice 2004-05, “Spent Fuel Pool Leakage to Onsite Groundwater,” March 3, 2004.

60. IE Information Notice No. 90-50, “Minimization of Methane Gas in Plant Systems and Radwaste Shipping Containers,” August 8, 1990.

61. Information Notice 2006-13, “Ground-Water Contamination Due to Undetected Leakage of Radioactive,” July 10, 2006.

62. Information Notice 2012-05, “Abnormal Releases of Radioactive Water Potentially Resulting in Groundwater Contamination,” April 25, 2012.

63. Regulatory Issue Summary 2008-03, “Return/Re-use of Previously Discharged Radioactive Effluents,” February 13, 2008.

64. 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).”

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