U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD for NuScale SMR DESIGN

11.3 GASEOUS WASTE MANAGEMENT SYSTEM

REVIEW RESPONSIBILITIES

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

Secondary - Organizations responsible for the review of (1) radwaste system design and performance, (2) ventilation systems, and (3) hydrogen control.

I. AREAS OF REVIEW

The small modular reactor (SMR) gaseous waste management system (GWMS) involves the gaseous radwaste system (GRS), which deals with the management of radioactive gases collected in the offgas system or in waste gas storage and decay tanks. In addition, it involves the management of a condenser air removal system, concentration of volatile neutron activation products in the reactor pool, purges of primary coolant leakage to the reactor containment vessel and its evacuation system in preparation for the transfer of reactor modules for refueling; hydrogen and oxygen recombiners and instrumentation to control hydrogen and oxygen levels; and gland seal exhausters. The GWMS also includes building ventilation system exhausts used to process ambient atmospheres from radiologically controlled areas where radioactive systems and components are located, and radioactive gases and vapors vented from components, such as tanks, vessels, and process equipment. The management for gaseous effluents to the environment from the above sources may, in turn, involve the use of mobile equipment connected to permanently installed systems to reduce releases of radioactive materials in effluents from the above sources.

The SMR GWMS has been categorized as nonsafety-related and nonrisk-significant. Failure of the GWMS 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 gaseous effluent releases and in complying with U.S. Nuclear Regulatory Commission (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 GWMS is relied on to control releases of radioactive materials in gaseous effluents to the environment; therefore, having a direct impact on public health and safety. As such, the review of the GWMS must be sufficient to assure that the staff has reasonable assurance that public health and safety is adequately protected.

The review of the GWMS includes the design, design objectives, design criteria, methods of treatment, system interfaces, bypass routes to nonradioactive systems, expected releases, methods used to terminate or divert effluent releases, and methods and principal parameters used in calculating effluent source terms and releases of radioactive materials (noble gases, radioiodines, tritium, carbon-14, and fission and activation products). The review will include 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 and ventilation system design capacities, expected flow rates or volumes, source terms and radionuclide concentrations, expected decontamination factors or removal efficiencies for radionuclides, and holdup or decay time.

2. System design capacity relative to the design and expected input flow rates and volumes, and the period of time the system is required to be in service to process normal waste flow rate and volumes.

3. Availability of standby equipment, alternate processing routes, and interconnections between permanently installed subsystems and skid mounted processing equipment in order to evaluate the overall ability of the system to meet anticipated demands imposed by major processing equipment downtime and waste volume surges caused by anticipated operational occurrences (AOOs).

4. Quality group classifications of structures, piping and equipment and the bases governing the 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 gaseous wastes produced during normal operation and AOOs.

5. Design provisions incorporated in the equipment and facility design to facilitate operation and maintenance in conformance with RG 1.143 for gaseous wastes produced during normal operation and AOOs.

6. Quality assurance (QA) provisions for radioactive waste management systems, structures and components (SSCs) in support of design criteria in accordance with the guidance of RG 1.143 for gaseous wastes produced during normal operation and AOOs.

7. Design features that would reduce the volumes of gaseous waste processed by the GWMS; reduce radioactivity levels and discharges of radioactive materials in gaseous 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.

8. Design features to reduce leakage of gaseous waste or discharges of radioactive materials in gaseous effluents to avoid uncontrolled and unmonitored releases to the environment under IE Bulletin 80-10 and RG 4.21, special design features, topical reports incorporated by reference, and data obtained from previous experience with similar systems as described in the application and other supporting documents (e.g., final safety analysis report (FSAR) of operating plants) in support of the design-basis.

9. 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.

10. Design features used to collect and vent radioactive gases and vapors from tanks, vessels, and processing equipment to the appropriate radioactive exhaust ventilation and filtration subsystems using the guidance of Standard Review Plan (SRP) Sections 9.4.1, 9.4.2, 9.4.4, DSRS Sections 11.2, 11.4, and RGs 1.52, 1.140 and 1.143.

11. For processing subsystems equipped with automatic control features, justification for the placement of isolation or diversion valves and radiation detectors on process piping and effluent discharge lines to ensure the timely closure of such valves upon the detection of elevated radioactivity levels, and, if part of the design, controls in monitoring deviations of in-plant exhaust flow rates and terminating releases or isolating process flows when deviations exceed preset limits.

12. Design features to preclude the possibility of an explosion if the potential for hydrogen and oxygen explosive mixtures exist in system components.

13. For multi-unit reactor stations, descriptions and design features of equipment and components (either as permanently installed systems or in combination with mobile processing equipment) normally shared between interconnected processing and treatment subsystems.

14. Types and characteristics of filtration and adsorbent media to treat gaseous 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.

15. Definition of the boundary of the GWMS, beginning at the interface from plant systems provided for the collection of process streams and radioactive gaseous waste to the points of controlled discharges to the environment as defined in the Offsite Dose Calculation Manual (ODCM), or at the point of storage in holdup tanks or decay beds in accordance with RG 1.143 for gaseous wastes produced during normal operation and AOOs.

16. 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 SSCs related to this section in accordance with 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 SRP Section 14.3 and RG 1.215.

17. 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 Title of the *Code of Federal Regulations* (CFR), Section 52.47(a)(24) to 52.47(a)(26), 10 CFR 52.79(d)(2), and 10 CFR 52.80(a).

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

requirements and restrictions (e.g., interface requirements and site parameters) 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 FSAR Tier 1 and Tier 2 information.

19. 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 gaseous effluents that would be generated as a normal byproduct of nuclear power operations. The estimates on the maximum doses to the public should be based on the bounding gaseous radiological effluents used in assessing potential exposures to the public by considering the probable pathways, based on site-specific or regional land-use information, to individuals and populations near the proposed new unit(s) for all expected activities. The staff should consider external exposure to the airborne plume, external exposure to contaminated ground, inhalation of airborne activity, ingestion of agricultural products impacted by plume deposition, and consumption of meat and milk products from livestock grazing on impacted pastures.

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 interface with this section as follows:

1. Review of the independent source term and dose calculations for the purpose of assessing the performance of the GWMS against the NRC requirements of

   A. 10 CFR 20.1301 and 20.1302; Table 2, Column 1, and Note 4 unity criterion of Appendix B to 10 CFR Part 20; and the design objectives of Appendix I to 10 CFR Part 50, is conducted under DSRS Section 11.1 using RG 1.112 and NUREG-0017 (as modified to reflect the design features of SMRs) and DSRS Section 11.5.

2. Review of design provisions of the GWMS to control, sample, and monitor radioactive materials in gaseous processes and effluent streams is performed under DSRS Section 11.5. The design of sampling systems should consider the guidance of American Standard National Institute/Health Physics Society (ANSI/HPS) N13.1-2011 for the placement of sample probes in stacks and ductwork, and in establishing sampling flow rates for the purpose of obtaining representative samples. The sampling system should minimize sample losses and distortion of the sample's chemical and physical properties.

3. 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 (GLs)) are performed under SRP Section 1.0.

4. The review of the definition of the exclusion area boundary (EAB) and administrative controls in managing gaseous effluent releases is performed in SRP Section 2.1.2 and DSRS Section 11.5.

5. The review of proposed short- and long-term atmospheric dispersion (X/Q) and deposition (D/Q) parameters, as they relate to the calculations of offsite gaseous effluent

concentrations and doses to members of the public, is performed under SRP Sections 2.3.1, 2.3.2, 2.3.3, 2.3.4, and 2.3.5.

6. Review of the dose calculation methods and parameters of the Standard Radiological Effluent Controls (SREC), as they relate to the ODCM is performed under DSRS Section 11.5 and SRP Sections 13.4 and 13.5.1.1, 13.5.1.2, 13.5.2.1, 13.5.2.2.

7. 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, and 3.8.5, and SRP Section 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 GWMS.

8. The review of the GWMS fire protection program for storage and use of inflammable gases, combustible radioactive wastes (e.g., spent high-efficiency particular air (HEPA) filters, and activated charcoals), and generation of combustible gas mixtures 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 combustible gases and inflammable materials.

9. Review of the acceptability of the seismic and quality group classifications for structures and system components is performed under SRP Sections 3.2.1 and 3.2.2.

10. The review of interfaces of radiation monitoring instrumentation and controls used by the GWMS, including provisions for automatic control features and interdependence with sensing elements other than radioactivity (e.g., valve and damper positions, and system differential 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 subsystems, operational ranges and qualification of sensing elements in supporting the functions of radiation monitoring subsystems, functional interdependence and logic in alarming and terminating or diverting process streams or effluent releases 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.

11. The review of the interface of the GWMS with the demineralized water makeup system, as it relates to the supply of seal water to systems and instrumentation containing radioactivity in preventing the contamination of non-radioactive systems and avoid unmonitored and uncontrolled releases to the environment.

12. The review of the interface of the GWMS with process gases collected from equipment vents and ambient atmospheres is performed in DSRS Sections 9.1.3, 9.2.6, 9.3.4, 9.3.6, and SRP Sections 9.2.2, 9.3.2, 9.3.3, 9.4.2, 9.4.3, 9.4.4, and 10.4.6.

13. The review of the interface of the GWMS with primary and secondary coolant systems as they relate to features provided to limit or reduce the buildup of radioactivity in tanks, steam generators, and other components is performed in DSRS Sections 5.2.4, 5.2.5, 11.5, and 12.3-12.4, SRP Sections 5.2.1.1, 5.2.1.2, 5.2.2, 5.2.3, 5.4, 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 guidelines, as described in DSRS Section 12.3-12.4.

14. The review of the interface of the GWMS discharge flow to the plant stack with other building exhaust ventilation systems to unrestricted areas, as site-specific balance of plant design features, is performed in SRP Sections 2.3.5, 9.4.1, 9.4.2, 9.4.3, 9.4.4, 9.4.5, and DSRS Section 11.5.

15. Review of applicable technical specifications (TS) for the GWMS is performed under DSRS Sections 16.0 and 11.5, as they relate to administrative programs on radioactive effluent controls and monitoring.

16. Review of QA is performed under SRP Sections 17.4, 17.5, 17.6, and RG 1.143 for systems not covered by Part 50, Appendix B requirements.

17. For any portion of the GWMS post-accident subsystems that supports safety-related functions, as identified by the applicant, the review of these design features is performed under DSRS Chapter 7 and SRP Section 13.3. In this context, the review, using RG 1.97, addresses the performance, design, qualification, display, QA, and selection of monitoring variables of radiation monitoring equipment required for accident monitoring and sampling.

18. Review of design features of building exhaust and ventilation systems servicing radiologically controlled areas where GWMS equipment and radioactive materials are located and used to vent tanks and process equipment (e.g., use of HEPA and charcoal filters) is conducted under DSRS Sections 9.4.1, 9.4.2, 9.4.3, 9.4.4, 9.4.5, and under DSRS Section 11.5 for instrumentation used to monitor and control radioactive effluent releases. 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.

19. The review of design features for the protection of potable and sanitary water systems from flow condensate generated by the GWMS is conducted 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.

20. The review of design features of the GWMS attributed for compliance with 10 CFR 20.1406, using RG 4.21, is performed in DSRS Section 12.3-12.4.

21. The review of design features of the GWMS credited for radiation protection of plant workers and compliance with 10 CFR Part 20, using RGs 8.8 and 8.10, is performed in DSRS Chapter 12.

22. The review of design features of GWMS subsystems and components associated with the plant's initial testing plan, description of tests, and testing acceptance criteria is performed in DSRS Sections 5.2.5, 5.4.7, 9.3.6, 10.4.7, 11.5, and 14.2, using RG 1.68, and SRP Sections 5.4.12, 9.3.2, 9.4.2, 9.4.3, 9.4.4, 10.4.1, 10.4.2, 10.4.3, 10.4.4, 10.4.5, and 10.4.6.

23. The completeness of the description of the GWMS design and its operational features are reviewed in SRP Section 14.3.7 to ensure that there is sufficient information for introduction in FSAR Tier 1 in confirming that ITAAC are inspectable and compliance can be demonstrated with no ambiguity.

24. Branch Technical Position (BTP) 11-5, as it relates to potential releases of radioactive materials (noble gases and radioiodines, as warranted), as a result of postulated leakage or failure of a waste gas storage tank or charcoal delay tank and doses at the EAB.

II. ACCEPTANCE CRITERIA

Requirements

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

1. 10 CFR Part 20.1101(b), as it relates to the use of procedures and engineering controls in maintaining doses to members of the public as low as is reasonably achievable (ALARA).

2. 10 CFR 20.1301 and 10 CFR 20.1302 and Table 2, Column 1 and Note 4 unity criterion of Appendix B to 10 CFR Part 20, as they relate to radioactivity in gaseous effluents released to unrestricted areas.

3. 10 CFR 20.1406, as it relates to the design and operational procedures (for applications other than renewals, after August 20, 1997) for minimizing contamination, facilitating eventual decommissioning, and minimizing the generation of radioactive waste.

4. 10 CFR Part 50.34, as it relates to the kinds and quantities of radioactive materials expected to be 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. 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2, as it relates to the design bases of structures housing GWMS and its components using the guidance of RG 1.143 in assigning seismic, safety, and quality group classifications for natural phenomena and for man-induced hazards in assigning the safety classifications to SSCs of the GWMS for design purposes.

8. Appendix A to 10 CFR Part 50, GDC 3, as it relates to the design of gaseous waste handling and treatment systems to minimize the generation of explosive gas mixtures and effects of explosive mixtures of hydrogen and oxygen on subsystems and components using RG 1.189, as it relates to the conduct of fire hazards analysis involving the presence of combustible gases and inflammable materials.

9. Appendix B to 10 CFR Part 50, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants, insofar, as it applies to GWMS subsystems and components not covered by the QA guidance of RG 1.143.

10. GDC 60, as it relates to the ability of the GWMS to control releases of radioactive materials to the environment.

11. GDC 61, as it relates to the ability of the GWMS design to ensure adequate safety under normal and postulated accident conditions, as described in DSRS Section 11.3, BTP 11-5 and analysis of RG 1.143 in assigning the safety classification to SSCs of the GWMS for design purposes.

12. 10 CFR Part 50, Appendix I, Sections II.B, II.C, 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" (ALARA) criterion.

13. 40 CFR Part 190 (EPA generally applicable environmental radiation standards), as implemented under 10 CFR 20.1301(e), as it relates to limits on total annual doses from all sources of radioactivity contained in gaseous effluents and external radiation from site buildings and facilities (with single or multiple reactor units). DSRS Sections 11.2 and 11.4 evaluate source terms and doses from liquid 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 contained sources of radioactivity contained in systems and components.

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 plant that incorporates the DC is built and will operate in accordance with the DC, the provisions of the Atomic Energy Act (AEA), and the NRC's 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 regulations.

16. 10 CFR Part 52.17(a), 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 Sections II.B and II.C of Appendix I 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 as follows for review described in this DSRS section. 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 DC Design, COL facility, or ESP Site), 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 the regulations (in 10 CFR 52.47(a)(9), 10CFR 52.79(a)(41), or 10 CFR 52.17(a)(1)(xii), as applicable).

1. The GWMS should have the capability to meet the dose design objectives and should include provisions to treat gaseous radioactive wastes such that the following is true:

   A. The calculated annual total quantity of all radioactive materials released from each reactor to the atmosphere will not result in an estimated annual external dose from gaseous effluents to any individual in unrestricted areas in excess of 0.05 mSv (5 mrem) to the total body or 0.15 mSv (15 mrem) to the skin. RGs 1.109, 1.111, and 1.112 provide acceptable methods for performing this analysis using the GASPAR II computer code (NUREG/CR-4653).

   B. The calculated annual total quantity of radioactive materials released from each reactor to the atmosphere will not result in an estimated annual air dose from gaseous effluents at any location near ground level which could be occupied by individuals in unrestricted areas in excess of 0.01 cGy (10 millirads) for gamma radiation or 0.02 cGy (20 millirads) for beta radiation. RGs 1.109, 1.111 and 1.112 provide acceptable methods for performing this analysis using the GASPAR II computer code (NUREG/CR-4653).

   C. The calculated annual total quantity of radioiodines, carbon-14, tritium, and all radioactive materials in particulate form released from each reactor at the site in effluents to the atmosphere will not result in an estimated annual dose or dose commitment from such releases for any individual in an unrestricted area from all pathways of exposure in excess of 0.15 mSv (15 mrem) to any organ. RGs 1.109, 1.111, and 1.112 provide acceptable methods for performing this analysis using the GASPAR II computer code (NUREG/CR-4653).

   D. The concentrations of radioactive materials in gaseous effluents released to an unrestricted area should not exceed the limits specified in Table 2, Column 1, and Note 4 unity criterion of Appendix B to 10 CFR Part 20.

   E. In addition to Sections 1.A, 1.B, and 1.C, above, the GWMS 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 dose to the population reasonably expected to be within 80 km (50 miles) of the reactor. RG 1.110 provides an acceptable method for performing this analysis.

   F. The regulatory position contained in RG 1.140 is met, as it relates to the design testing and maintenance of normal ventilation exhaust system air filtration and adsorption units at nuclear power plants.

   G. The regulatory position contained in RG 1.143 is met, as it relates to the seismic design, quality group, and safety classification of components used in the structures housing the GWMS and the provisions used to control leakages of gaseous wastes produced during normal operation and AOOs.

   H. The regulatory position contained in RG 1.143 is met, as it relates to the definition of the boundary of the GWMS, beginning at the interface from plant systems to the point of controlled discharges to the environment as defined in the ODCM, or at the point of storage in holdup tanks or decay beds for gaseous wastes produced during normal operation and AOOs.

2. The GWMS should be designed with adequate capacity to process gaseous 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, the reviewer will consider shared systems, redundant equipment, mobile equipment, and reserve storage and treatment capacity.

3. The seismic design and quality group and safety classification of components used in the GWMS and structures housing the system should conform to RG 1.143. The design should include precautions to stop continuous leakage paths (i.e., to provide liquid seals downstream of rupture discs) and to prevent permanent loss of the liquid seals in the event of an explosion due to gaseous 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 whether system components comply with RG 1.143. 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 gaseous waste management system (GWMS) should be designed to implement the requirements of 10 CFR 20.1406. System designs should describe features that will minimize, to the extent practicable, contamination of the facility and environment; facilitate eventual decommissioning; and minimize, to the extent practicable, the generation of radioactive waste in accordance with the guidelines of Interim Staff Guidance (ISG), DC/COL-ISG-06 and RG 1.33, 1.143 and 4.21, and NEI 08-08A for gaseous wastes produced during normal operation and AOOs.

5. System designs should use the guidance in RG 1.52, 1.140 and 1.143 for the design testing and maintenance of HEPA filters and charcoal adsorbers installed in normal ventilation exhaust systems. If decontamination factors for radioiodines differ from those specified in RG 1.140 are used for design purposes, they should be supported by test data or industry standards under operating or simulated operating conditions, such as temperature, pressure, humidity, expected iodine concentrations, flow rate, type of charcoal (grade, mesh size and bulk density), and numbers and volume of delay tanks, dynamic adsorption coefficients for charcoal media, and retention times. The test data should also support the effects of aging and poisoning by airborne contaminants.

6. For processing subsystems equipped with automatic control features, the design should provide the justification for the placement of isolation or diversion dampers/valves and radiation detectors on process piping and effluent discharge lines to ensure the timely closure of such valves upon the detection of elevated radioactivity levels, and, if part of the design, controls in monitoring deviations of in-plant exhaust flow rates and terminating releases or isolating process flows when deviations exceed preset limits. Acceptable guidance is presented in DSRS Section 11.5 and American Nuclear Society (ANS) N42.18-2004.

7. If the potential for explosive mixtures of hydrogen and oxygen exists, the GWMS portion of the GWMS should either be designed to withstand the effects of a hydrogen explosion or be provided with dual gas analyzers with automatic control functions to preclude the formation or buildup of explosive mixtures. The GWMS is normally the only portion of the system that is vulnerable to potential hydrogen explosion.

   A. For a system designed to withstand the effects of a hydrogen explosion, the design pressure of the system should be approximately 20 times the operating absolute pressure.

   B. Small allowances should be made to conform to standard design pressures for off-the-shelf components (e.g., if the system operating pressure is nominally 103 kPa (15 psia) but could approach 138 kPa (20 psia) by design, piping could be designed to 2413 kPa (350 psia), since the next higher standard pressure rating is 4137 kPa (600 psia).

   C. The process gas stream should be analyzed for potentially explosive mixtures and annunciated both locally and in the control room.

   D. For systems not designed to withstand a hydrogen explosion, dual gas analyzers (with dual being defined as two independent gas analyzers continuously operating and providing two independent measurements verifying that hydrogen and/or oxygen are not present in potentially explosive concentrations) with automatic control functions are required to preclude the formation or buildup of explosive hydrogen/oxygen mixtures. Gas analyzers should annunciate alarms both locally and in the control room. Analyzer “high alarm” setpoints should be set at approximately 2 percent and “high-high alarm” setpoints should be set at a maximum of 4 percent hydrogen or oxygen.

      Control features to reduce the potential for explosion should be automatically initiated at the “high-high alarm” setting. The automatic control features should be as follows:

      i. For systems designed to preclude explosions by maintaining either hydrogen or oxygen below 4 percent, the source of hydrogen or oxygen (as appropriate) should be automatically isolated from the system (valves should fail in closed position).

      ii. For systems using recombiners, if the downstream hydrogen and/or oxygen concentration exceeds 4 percent (as appropriate), acceptable control features include automatic switching to an alternate recombiner train.

      iii. Injection of diluents to reduce concentrations below the limits specified herein.

      Systems designed to operate below 4 percent hydrogen and below 4 percent oxygen may be analyzed for either hydrogen or oxygen; systems designed to operate below 4 percent hydrogen only (no oxygen restrictions) should be analyzed for hydrogen; and systems designed to operate above 4 percent hydrogen should be analyzed for oxygen.

      For systems using recombiners, analysis for hydrogen and/or oxygen should be downstream of the recombiners. In addition, unless the system design features

preclude explosive gas mixtures of hydrogen and oxygen upstream of the recombiners, analysis for hydrogen and/or oxygen (as appropriate) should be upstream of the recombiners as well.

The number of gas analyzers and control features at each location should be in accordance with this DSRS section. One gas analyzer upstream and one gas analyzer downstream of the recombiners should not be construed as dual gas analyzers. For systems involving pressurized storage tanks (excluding surge tanks), at least one gas analyzer is required between the compressor and the storage tanks. Dual gas analyzers set to sequentially measure concentrations both upstream and downstream of a recombiner are acceptable. When two or more potentially explosive process streams are combined before entering a component, each stream or the combination thereof, is required to have dual gas analyzers.

If gas analyzers are to be used to sequentially measure several points in a system not designed to withstand a hydrogen explosion, at least one gas analyzer which is continuously on stream is required. The continuous gas analyzer should be located at a point common to streams and measured sequentially (i.e., the analyzer should be sampling the combined stream).

Gas analyzers should have daily sensor checks, monthly functional checks, and quarterly calibrations.

Gas analyzers installed in systems designed to withstand a hydrogen explosion should be capable of withstanding a hydrogen explosion; gas analyzers installed in the systems not designed to withstand a hydrogen explosion need not be capable of withstanding a hydrogen explosion (similar requirements apply to radiation monitors which are internal to lines containing potentially explosive mixtures).

All gas analyzer instrumentation systems shall be non-sparking.

8. BTP 11-5, as it relates to potential releases of radioactive materials (noble gases and iodines) as a result of postulated leakage or failure of a waste gas storage tank or charcoal delay tank.

9. For an ESP application, the dose estimates to a hypothetical maximally exposed member of the public from gaseous effluents using radiological exposure models are developed based on RGs 1.109, 1.111 or 1.112, and appropriate computer codes, such as the GASPAR II computer code (NUREG/CR-4653) for gaseous effluents.

10. The relevant RGs and ISG and BTP are as follows:

    A. RG 1.110, as it relates to performing a cost-benefit analysis for reducing cumulative dose to the population by using available technology.

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

    C. 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 20 and 10 CFR Part 50, Appendix I dose objectives and ALARA provisions.

D. RG 1.111, as it relates to the use of acceptable methods for estimating atmospheric dispersion and deposition parameters of gaseous effluents in demonstrating compliance with 10 CFR Part 50, Appendix I dose objectives and effluent concentration limits and Note 4 unity criterion of Part 20, Appendix B, Table 2, Column 1.

E. RG 1.143, as it relates to QA provisions for radioactive waste management SSCs, insofar, as it applies to GWMS subsystems and components not covered by the QA requirements of Appendix B to 10 CFR Part 50.

F. RG 1.143, as it relates to the seismic design, safety, and quality group classifications of components used in the GWMS and structures housing the systems and the provisions used to control leakages of liquids (collected as condensate) produced during normal operation and AOOs, and natural phenomena and man-induced hazards listed in RG 1.143 in assigning the safety classifications to SSCs of the GWMS for design purposes.

G. RG 1.143, as it relates to the definition of the boundary of the GWMS, beginning at the interface from plant systems provided for the collection of process streams and radioactive gaseous waste to the points of controlled discharges to the environment as defined in the ODCM, or at the point of storage in holdup tanks or decay beds in accordance with RG 1.143 for gaseous wastes produced during normal operation and AOOs.

H. DC/COL-ISG-06, NEI 08-08A, and RG 4.21, as they relate to acceptable levels of detail and content required to demonstrate compliance with 10 CFR 20.1406.

I. BTP 11-5, as it relates to potential releases of radioactive materials (noble gases and iodines) as a result of postulated leakage or failure of a waste gas storage tank or charcoal delay tank and doses at the EAB.

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 contained in 10 CFR 20.1301.

   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). One of these approaches requires a demonstration of the following:

   A. 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 values specified in Table 2, Column 1, and Note 4 unity criterion of Appendix B to 10 CFR Part 20.

B. That the annual and hourly doses from external sources to an individual continuously present in an unrestricted area will not exceed 0.5 mSv (0.05 rem) and 0.02 mSv (0.002 rem), respectively.

Meeting the above requirements provides reasonable assurance that the dose limits to individual members of the public specified in 10 CFR 20.1301 will not be exceeded. The review detailed in this DSRS section will evaluate the ability of the system to meet the dose requirements identified above. DSRS Section 11.2 identifies compliance with the limits on liquid effluent concentrations in unrestricted areas as an acceptance criterion; consequently, the ability of a facility to meet this criterion will be evaluated and presented in DSRS Section 11.2.

In calculating offsite gaseous effluent concentrations and doses to members of the public, the acceptability of the proposed short and long-term atmospheric dispersion and deposition parameters is determined as part of the review of the information presented in SRP Sections 2.3.4 and 2.3.5.

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, 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 they relate to the GWMS, provides reasonable assurance that nuclear power reactors 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 GWMS will have the necessary design features and equipment to control releases of gaseous effluent to the environment in accordance with the requirements of 10 CFR 20.1301 and 20.1302, and 10 CFR 20.1301(e); Appendix I to 10 CFR Part 50; and GDCs 60 and 61.

4. GDC 3 provides 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 regard to the GWMS, if a potential for explosive hydrogen and oxygen mixtures exists, then designing the GRS to withstand the effects of such an explosion or providing the GRS with dual instrumentation and design features to annunciate and prevent the buildup of potentially explosive mixtures, satisfies the requirements of GDC 3.

   Meeting the requirements of GDC 3 provides assurance that the GRS is protected from the effects of an explosive mixture of hydrogen and oxygen and that the safety functions of other SSCs will not be compromised in meeting the effluent discharge concentrations of 10 CFR Part 20. Supporting NRC guidance is provided in RG 1.189, as it relates to the conduct of fire hazards analysis involving the presence of combustible gases.

5. Compliance with GDC 60 requires that each nuclear power plant design shall include means to control releases of radioactive materials in gaseous effluents to the environment during normal reactor operation, including AOOs.

GDC 60 specifies that the waste management systems provide for a holdup capacity sufficient to retain 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 the pressurized-water reactor (PWR)-GALE Code referred to in NUREG-0017 and RG 1.112, as modified to reflect the design features of SMRs. The applicant should document the basis of any difference, 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.

The review should evaluate the types and characteristics of filtration systems and adsorbent media proposed to treat gaseous process and effluent streams, including type of charcoal media (grade, mesh size, and bulk density), number and volume of charcoal delay tanks, dynamic adsorption coefficients for charcoal media, and retention times, removal efficiencies and decontamination factors, taking into account the expected physical, chemical, and radiological properties of gaseous process and effluent streams, and processing flow rates. The review should determine whether performance meets or exceeds that noted in RG 1.52 and 1.140 and NUREG-0017 (as modified). The above information may be drawn from standard DCs, industry standards, and/or topical reports, and industry data for new or alternate gaseous waste treatment methods.

Meeting the requirements of GDC 60 provides reasonable assurance that releases of radioactive materials in gaseous effluents to unrestricted areas during normal operation of the plant and AOOs will not result in offsite radiation doses exceeding the dose objectives specified in Appendix I to 10 CFR Part 50 and concentrations of radioactive materials in gaseous effluents in any unrestricted area exceeding the limits specified in Table 2, Column 1, and Note 4 unity criterion of Appendix B to 10 CFR Part 20.

The control of radioactive gases and vapors, generated as byproducts of the operation of the LWMS and solid waste management system is addressed here as part design considerations of exhaust ventilation and treatment subsystems under the guidance of SRP Sections 9.4.1, 9.4.2, 9.4.3, 9.4.4, 9.4.5, DSRS Sections 11.2, 11.4, and 11.5, and RG 1.52, 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 and SMWS 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 GWMS and other systems (either as permanently installed systems or in combination with mobile equipment) that may contain radioactivity shall be designed to assure adequate safety under normal and postulated accident conditions, including adverse vacuum conditions on system components. 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.

   RGs 1.52 and 1.140 provide design guidance acceptable to the NRC staff relating to design, testing, and maintenance criteria for air filtration and adsorption units, and RG 1.143 describes design guidance acceptable to the NRC staff relating to seismic and quality group classification, safety classification, and QA provisions for the GWMS

portion of the GWMS structures and components, involving gaseous wastes produced during normal operation and AOOs and natural phenomena and man-induced hazards listed in RG 1.143 in assigning the safety classifications to SSCs of the GWMS for design purposes.

Meeting the requirements of GDC 61 provides reasonable assurance that releases of radioactive materials during normal operation and during AOOs will not result in radioactive material concentrations and radiation doses that exceed the limits specified in 10 CFR 20.1302. 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. In addition, meeting these requirements will help to assure that the GWMS will continue to perform its safety functions under postulated accident conditions, given the guidance of RG 1.52.

RG 1.143 describes design guidance acceptable to the NRC staff related to seismic, safety, and quality group classifications and QA provisions for the subsystems, structures, and components of the GWMS for gaseous wastes and effluents produced during normal operation and AOOs. RG 1.143 provides guidance in assigning safety classifications to structures and radioactive waste management systems in protecting SSCs against natural phenomena and man-induced hazards. For unmitigated releases of radioactive materials, the acceptance criterion of RG 1.143 is 1 mSv (100 mrem) for members of the public assumed to be located at or beyond the restricted area or in unrestricted areas (whichever is most limiting). For unmitigated radiation exposures to site personnel, the acceptance criterion is 5 rem (50 mSv) for a plant worker assumed to be located in the restricted area. In classifying system components, the radioactivity inventories of components are compared to the 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.

Implementation of the guidance of RG 1.143 provides reasonable assurance that the assigned safety classifications for structures housing the GWMS and its components comply with the requirements of GDCs 2 and 61, RG 1.143 for natural phenomena and man-induced hazards. Meeting the requirements of GDCs 2 and 61 provide reasonable assurance that the necessary information is available to identify the amounts of radioactive materials contained in GWMS and assess the radiological impacts during postulated accidents, as described in DSRS Section 11.3, BTP 11-5, and analysis of RG 1.143 in assigning the safety classifications to SSCs of the GWMS for design purposes. Appendix I to 10 CFR Part 50 provides numerical guidance for design objectives to meet the requirements that radiation doses from radioactive materials in effluents released to unrestricted areas be kept ALARA. Sections II.B, II.C and II.D of Appendix I relates to the numerical guides for design objectives, limiting conditions for operation, and controls to meet the ALARA criterion for gaseous effluents.

7. RGs 1.109 and 1.111 provide acceptable methods in performing dose analyses to demonstrate that the GWMS design results in doses from releases of radioactive materials from each reactor that comply with the Appendix I dose objectives.

   RG 1.110 provides an acceptable method of performing cost-benefit analysis to demonstrate that the GWMS design includes all items of reasonably demonstrated technology capable of reducing cumulative population doses from releases of radioactive materials in effluents from each reactor to levels ALARA.

RG 1.140 presents methods acceptable to the NRC staff for implementing the regulations in Appendix I to 10 CFR Part 50 by providing guidance on the design, testing, and maintenance criteria for HEPA filters and charcoal absorbers in filtration systems.

The requirements of Sections II.B, II.C and II.D of Appendix I to 10 CFR Part 50 provide reasonable assurance that the limits for external radiation doses to a maximally exposed offsite individual, maximum offsite air doses from noble gases (as gamma and beta radiation), and radiation doses from carbon-14, tritium, fission and activation products , and radioiodines to a maximally exposed offsite individual from gaseous effluents, specified in Sections II.B and II.C, and the acceptance criterion for cost-benefit analysis specified in Section II.D for meeting ALARA objectives will be met.

8. BTP 11-5 describes acceptable methods to evaluate EAB doses associated with the postulated releases of radioactive gases and iodines resulting from the failure of a gas storage tank or charcoal decay tank or a leak from a GWMS component.

   The BTP presents guidance for selecting the type of failure and model assumptions that provide reasonable assurance that the radiological consequences of a single failure of an active component will not result in doses exceeding a small fraction (10 percent) of the 10 CFR Part 100 dose limits for the whole body to any offsite individuals for the postulated event of systems designed to withstand explosions and earthquakes, or 1 mSv (0.1 rem) for systems not designed to withstand explosions and earthquakes. The analysis assumes that the waste gas system fails to meet its design bases, as required by 10 CFR 50.34a and GDCs 60 and 61. The analysis relies on methods described in BTP 11-5 and the use of the PWR-GALE code (NUREG-0017) and RG 1.112, as modified to reflect the design features of SMRs. The applicant should document the basis of any difference, 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. The review of proposed short-term atmospheric dispersion parameters, as they relate to the calculation of doses at the EAB, is performed under SRP Section 2.3.4.

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 with single or multiple reactor units. DSRS Sections 11.2 and 11.4 address the sources of radioactivity and doses associated with liquid effluents and solid wastes, respectively. DSRS Section 12.3-12.4 addresses the source 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 should include consideration of whether doses due to gaseous and liquid 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 or in one sector 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 GWMS has been categorized as nonsafety-related and nonrisk-significant, the failure of specific systems or components may have some impacts on the means to control and monitor gaseous effluent releases and in complying with NRC regulations under 10 CFR Part 20 and Part 50, Appendix I. As such, the review of the GWMS requires a more detailed review than other nonsafety-related and nonrisk-significant systems given its direct impact on public health and safety. The staff will evaluate whether the failure of a GWMS system would compromise any safety-related system or component, nor should it prevent the safe-shutdown of the plant. The applicant's FSAR and failure analysis will be reviewed to confirm that sufficient information has been provided to confirm that the failure of essential subsystems will not result in plant or operating conditions in noncompliance with NRC regulations on exposure to workers and members of the public and are consistent with DSRS acceptance criteria.

The NRC will review the description of the design features of the GWMS provided in the technical submittal, including DSRS Sections 11.1, 11.2, 11.4, 11.5, and 12.3-12.4, for completeness in accordance with RG 1.70 or 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)

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.

2. Programmatic requirements. Commission regulations and policy mandate "programs" applicable to SSCs that include:

   A. TS, Section 5 Administrative Controls, as they relate to administrative programs on radioactive effluent controls and monitoring via the ODCM, SREC, and radiological environmental monitoring program. The review of the SREC, ODCM, and REMP may be conducted as part of the review of DSRS Section 11.4 or 11.5, depending on where the applicant has located the procedural details and programmatic controls given the provisions of GL 89-01 and NUREG-1301.

   B. Startup initial testing plan, as described in DSRS Section 14.2 using RGs 1.68 and 1.33.

   C. Implementation of these programs will be inspected in accordance with NRC Inspection Manual Chapter IMC-2504, "Construction Inspection Program - Non-ITAAC Inspections."

   D. For DCDs with radioactive waste facilities which could contain radioactive material in excess of their design basis, a COL Item requiring either a License Condition in applications Part 10 – "ITAAC and Proposed License Conditions," or a Program element in Technical Specifications Section 5.5 (Programs and Manuals), to ensure that the SSCs are operated within their design bases.

E. For COL applications referencing a DCD with radioactive waste facilities which could contain radioactive material in excess of their design bases, verify the presence of either a License Condition in applications Part 10 – "ITAAC and Proposed License Conditions," or a Program element in Technical Specifications Section 5.5 (Programs and Manuals), that ensures that the SSCs are operated within their design bases.

3. 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.

4. The review of the GWMS will evaluate P&IDs to identify all sources and amounts of gaseous waste; points of collection of gaseous wastes; flow paths of gases through subsystems, including all potential bypasses to nonradioactive systems; treatment methods and expected decontamination factors or removal efficiencies and holdup or decay times; and points of release of gaseous 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 gaseous releases and liquids from collection of GWMS condensates.

   This information is used to calculate the quantity of radioactive materials released annually in gaseous effluents during normal operations, including AOOs, using the given parameters and calculational techniques referred to in NUREG-0017 and RG 1.112 (as modified) in reflecting design-specific features of SMRs. 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 gaseous effluents and implementation of DSRS acceptance criteria and regulatory guidance. The results of this calculation will determine whether the proposed GWMS design meets the acceptance criterion of DSRS Section II, Acceptance Criteria 1 to 6 of this DSRS section and relevant sections of DSRS Section 11.1.

   Implementation of the guidance in DSRS, Section II, Acceptance Criteria 1.A, 1.B, 1.C, and 1.D of this DSRS section concerning exposures of the total body, skin, and thyroid will be determined based on dose and source term calculations performed by NRC staff using methods described in NUREG-0017, and RG 1.112 (as modified), and NUREG/CR-4653 (GASPAR II code).

   The NRC staff will determine conformance with DSRS, Section II, Acceptance Criteria 1.E of this DSRS Section, concerning the cost-benefit analysis based on an analysis that includes population cumulative dose calculations (person-Sv (person-rem))

and cost-benefit studies. RG 1.110 describes methods for performing such cost-benefit analyses.

5. The review of the GWMS design capacity will encompass the following major areas:

   A. The capability of the GRS to process gaseous wastes in the event of a single major equipment item failure. For non-redundant equipment or components, a 3-week downtime every other year will be assumed (10 days per year average).

   B. The capability of the GRS to process gaseous wastes at design-basis fission product levels. Source terms are evaluated 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 adjusted parameters used in the PWR-GALE code to allow the staff to conduct an independent evaluation of the applicant's use of alternate code parameters, given sufficient information.

   C. The operational flexibility designed into the GRS (e.g., cross-connections between subsystems, redundant or reserve processing equipment, and reserve storage capacity, including the use of mobile processing and treatment systems).

   D. In the evaluation of charcoal delay systems for radioactive gas decay, the number of beds or tanks, bed or tank volumes and dimensions, mass of charcoal each bed or tank, charcoal mesh size and bulk density, processing flow rates, temperatures, pressures, humidity, and dynamic adsorption coefficients used to calculate the effective holdup times.

   E. Types and characteristics of filtration and adsorbent media to treat gaseous process and effluent streams, with removal efficiencies and decontamination factors meeting or exceeding the performance of NRC generic guidance (RG 1.112 and NUREG-0017 (as modified) and RG 1.140, standard DCs, or topical reports, taking into account the expected physical, chemical, and radiological properties of gaseous process and effluent streams.

   F. For processing subsystems 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 exhaust vents and stacks to ensure the timely closure of such dampers/valves upon the detection of elevated radioactivity levels, and, if part of the design, controls in monitoring deviations of in-plant exhaust 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

   G. Analysis and results demonstrating the implementation of BTP 11-5 for doses to any offsite individuals associated with the postulated failure of a waste gas system component or leak.

   H. In calculating offsite gaseous effluent concentrations and doses to members of the public, the acceptability of the proposed short and long-term atmospheric

dispersion and deposition parameters is determined as part of the review of the information presented in SRP Sections 2.3.4 and 2.3.5.

The average input flow rates and volumes are compared with the design flows to determine the fraction of time individual subsystems must be online to process normal waste inputs. The review includes the operational flexibility designed into the system (i.e., cross-connections between subsystems, 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 to F above, is performed by comparing design flows with the potential process routes and equipment capacities. System capabilities to treat and hold for decay will be evaluated using the guidance and methods described in NUREG-0017 and RG 1.112, as modified to reflect the design features of SMRs. If an alternate method includes the use of mobile processing systems connected to permanently installed GWMS subsystems, the staff will conduct a parallel review and evaluation of such a method using the above guidance and acceptance criteria.

6. The quality group and safety classifications of piping and equipment in the GRS portion of the GWMS is compared to the guidance of RGs 4.21 and 1.143 for gaseous wastes produced during normal operation and AOOs. The seismic design criteria of equipment and of structures housing the GRS are also compared to the design guidance identified in RG 1.143. When applicable, DSRS Sections and 3.7.1 through 3.7.3, 3.8.4, 3.8.5 and SRP Section 3.2.1, 3.2.2, 3.3.1, 3.3.2, 3.5.3, 3.7.4 will be used to evaluate exceptions.

7. The GRS design, system layout, equipment design, method of operation, and provisions to reduce leakage and to facilitate operations and maintenance are compared to RGs 4.21 and 1.143 for gaseous wastes produced during normal operation and AOOs, including adverse vacuum conditions on components. Special design features provided to control leakage from system components and/or topical reports on system designs will be evaluated on a case-by-case basis.

   The applicant's design is compared to RG 1.143, as acceptable guidance, related to seismic, safety, and quality group classifications and QA provisions for the subsystems, structures, and components of the GWMS for gaseous wastes and effluents produced during normal operation and AOOs. RG 1.143 provides guidance in assigning safety classifications to structures and radioactive waste management systems in protecting SSCs against natural phenomena and man-induced hazards. For unmitigated releases of radioactive materials, the acceptance criterion of RG 1.143 is 1 mSv (100 mrem) for members of the public assumed to be located at or beyond the restricted area or in unrestricted areas (whichever is most limiting). For unmitigated radiation exposures to site personnel, the acceptance criterion is 5 rem (50 mSv) for a plant worker assumed to be located in the restricted area. In classifying system components, the radioactivity inventories of components are compared to the criteria in determining the appropriate safety classification. In addition, RG 1.206, Part I, Regulatory Position C.I.3, 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.

8. The review will compare the design, testing, and maintenance criteria for HEPA filters and charcoal absorbers in filtration systems against the provisions of RG 1.140.

9. If a potential for explosive hydrogen and oxygen mixtures exist, it will be determined, using the system description and P&IDs, whether the applicant has designed the GRS to withstand the effects of such an explosion or has provided the required dual instrumentation and design features to annunciate and prevent the buildup of potentially explosive mixtures, respectively.

   The applicant's design is reviewed to ensure that it includes adequate provisions to stop continuous leakage paths after an explosion. The areas of concern are (1) process streams where water decomposition gases (hydrogen and oxygen) exist, (2) cover gas streams where air in-leakage can occur, and (3) areas where there is a possibility of liquid hydrocarbons and ozone collecting in a cryogenic distillation system.

10. 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. 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 the limiting conditions for operation and their bases as being consistent with the plant design. The ODCM, SREC, and TS are reviewed with respect to the requirements of 10 CFR 50.36a using GL 89-01 and guidance contained in NUREG-1301 or 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.

11. BTP 11-5 describes acceptable methods to evaluate the consequences associated with the postulated release of radioactive noble gases and radioiodines following the failure of a waste gas system component. The associated exposure pathways include direct radiation exposures and inhalation for a receptor assumed to be located at the EAB. Supporting information on the staff's evaluation of the site's atmospheric dispersion characteristics in transporting radioactivity into unrestricted areas is presented in SRP Section 2.3.4. The use of proposed short-term EAB atmospheric dispersion parameters in support of dose calculation is based on the acceptability of the information evaluated as part of the review of SRP Section 2.3.4.

    The reviewer will evaluate the type of event leading to the assumed component failure and release; the assumed radioactive source term; process by which the radioactivity is assumed to be released in the environment from the plant; use of system design features and credit assumed in mitigating the amounts of radioactivity released; duration of the release; selection of proper atmospheric dispersion parameters; basis for the selection of the EAB sector as the location of the dose receptor; and dose results and comparison of doses against BTP 11-5 acceptance criteria.

    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 11-5, and confirm whether the acceptance criteria of BTP 11-5 are met for a dose receptor assumed to be located at the EAB. Alternatively, for plant system features and site characteristics incapable of meeting the acceptance criteria of BTP 11-5, the reviewer will evaluate proposed special design features applied in mitigating the effects of a postulated failure and determine whether such design features are adequate and acceptable given the objectives of BTP 11-5. If the results of a plant and site-specific analysis do not meet BTP 11-5 acceptance criteria, the

applicant is expected to propose TS limiting the total amount of radioactivity contained in GWMS components. The staff will evaluate the proposed TS limiting the radioactivity content of GWMS 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.

12. The GWMS is reviewed to ensure that the design includes provisions to 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 will provide reasonable assurance that leaks and inadvertent discharges of radioactive effluents will be prevented or minimized to the extent practicable.

    B. In the event the 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 rates.

    C. Design features should be supplemented, as necessary, by operating programs, processes and procedures to monitor leaks and evaluate their impact to the environment.

    D. Design features that facilitate decommissioning should be described, and their role in the decommissioning process should be described. 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.

    E. The site has been designed and will be operated to minimize the generation and volume of radioactive waste; both during operation and during decommissioning (e.g., reuse charcoal adsorbent media via regeneration when feasible).

    In addressing the above NRC guidance includes the following:

    A. IE Bulletin No. 80-10; GL 99-02; IE Circulars 79-21 and 80-18; and IE Information Notices 82-43, 82-49, 91-40, and 99-01.

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

    C. RGs 1.11, 1.143 and 4.21 for system process streams, gaseous wastes, and gaseous effluents produced during normal operation and AOOs; and NUREG/CR-3587, as it relates to techniques used in decommissioning light water reactors.

    D. SRP Sections 9.4.1, 9.4.2, 9.4.4, and DSRS Section 10.4.7.

    E. NRC endorsed industry guidance and standards NEI 08-08A, ANSI/ANS-55.4-1993 (R2007) and ANSI/ANS-40.37-2009.

13. In determining compliance with 40 CFR Part 190, as implemented under 10 CFR 20.1301(e), the review considers all sources of radiation and radioactivity as a potential contributor to doses to members of the public from the site, which may have either 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 gaseous effluents, while DSRS Sections 11.2 and 11.4 evaluate source terms and doses from liquid 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 doses associated with external radiation from buildings and sources of radioactivity contained in systems and components.

    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 or in one sector 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.

14. 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 these COL action items are addressed during a COL application, they should be added to the DC FSAR Sections 1.8 and 1.9.

    For 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 FSAR Tier 1 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).

15. Subpart A to 10 CFR Part 52 specifies the requirements applicable to the Commission's review of an ESP application. Information required in an ESP application includes a description of the site characteristics and design parameters of the proposed site. For an ESP application, the staff reviews the estimates of the source terms for gaseous 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. For gaseous effluents, the staff confirms that atmospheric dispersion characteristics and deposition parameters used in calculating offsite doses are consistent with the information presented in Section 2.3.5 of the applicant's technical submittal.

    The staff should confirm the approach used by the applicant in developing the annual average gaseous effluent source terms from all release points, e.g., plant stack, building vents, etc. 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.

    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 ESP at the COL stage. Accordingly, the reviewer should ensure that all physical attributes of the site that could affect the design basis of SSCs important to safety are reflected in the site characteristics, design parameters, or terms and conditions on the ESP.

    The staff should confirm that exposure pathways are based on site-specific or regional land-use information and include all appropriate dose receptors and populations near the proposed new unit(s) for all expected activities. Exposure pathways should include external exposures to airborne plumes, external exposure to contaminated ground, inhalation of airborne activity, and ingestion of agricultural products, and consumption of meat and milk products from grazing livestock. 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 permit condition for consideration in a COL application. The permit condition 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 bases for those conclusions.

The staff concludes that the design of the GWMS (as a permanently installed system or in combination with mobile systems) includes the equipment necessary to process and control releases of radioactive materials in gaseous effluents in accordance with GDCs 2, 3, 60, and 61 of Appendix A to 10 CFR Part 50 and 10 CFR 50.34a. The staff concludes that the design of the GWMS is acceptable and meets the requirements of 10 CFR 20.1301 and 20.1302, 10 CFR 20.1301(e), and 10 CFR 20.1406; 10 CFR 50.34a and 10 CFR 50.36a; GDCs 2, 3, 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 GDCs 60 and 61 with respect to controlling releases of radioactive materials to the environment by assuring that the design of the GWMS includes the equipment and instruments necessary to detect and control the release of radioactive materials in gaseous effluents.

2. The applicant has met the requirements of Appendix I to 10 CFR Part 50 by meeting the ALARA criterion as follows:

   A. Regarding Sections II.B and II.C of Appendix I, the staff has considered releases of radioactive material in gaseous effluents for normal operation, including AOOs, based on expected amounts and concentrations of gaseous wastes over the life of the plant for each reactor on the site. The staff has determined that the proposed GWMS is capable of maintaining releases of radioactive materials in gaseous effluents such that the calculated individual doses in an unrestricted area from all pathways of exposure are less than 0.05 mSv (5 mrem) to the total body or 0.15 mSv (15 mrem) to the skin and less than 0.15 mSv (15 mrem) to any organ from releases of radioiodines, tritium, carbon-14, and radioactive materials in particulate form.
   B. The staff has determined that the calculated air doses from gaseous effluents at any location near ground level that could be occupied by individuals in unrestricted areas will be less than 0.01 cGy (10 millirads) for gamma radiation and 0.02 cGy (20 millirads) for beta radiation.

   C. Regarding Section II.D of Appendix I, the staff has considered the potential effectiveness of augmenting the proposed GWMS using reasonably demonstrated technology and determined that further gaseous effluent treatment will not effect reductions in cumulative population doses within an 80-km (50-mile) radius of the reactor at a cost of less than $1000 per man-rem or $1000 per man-thyroid-rem.

3. The applicant has met the requirements of 10 CFR 20.1301 and 10 CFR 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 coolant. The design basis fuel defect level is reviewed under DSRS Section 11.1. The staff has determined that under these conditions, the concentrations of radioactive materials in gaseous effluents in unrestricted areas will comply with the concentration limits specified in Table 2, Column 1, and Note 4 unity criterion of Appendix B to 10 CFR Part 20. In making the above determination for radioiodines and noble gases, the staff has considered TS limits as I-131 and Xe-133 dose equivalent concentrations in the primary and secondary coolant for SMRs, as defined in 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 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). DSRS Section 12.3-12.4 evaluates the doses associated with external radiation from buildings and sources of radioactivity contained in systems and components.

5. 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 gaseous effluent discharges or diverting process flows to subsystems for storage and decay or further processing, as needed.

6. The staff has considered the ability of the proposed GWMS to meet the anticipated 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.

7. The staff has reviewed the design features and operational programs and procedures to minimize, to the extent practicable, contamination of the facility and the environment; facilitate decommissioning; and minimize, to the extent practicable, the generation of radioactive waste, with supplemental information presented in DSRS Section 12.3. The staff concludes that the proposed design features and operational programs and procedures are consistent with NRC guidance and the requirements of 10 CFR 20.1406.

8. The staff has reviewed the applicant's QA provisions for the GRS portion of the GWMS, the quality group and safety classifications used for the GRS components, the seismic design applied to the design of the GRS, and the structures housing the GRS. The design of the GRS and the structures housing it meet the criteria set forth in RG 1.143 for gaseous wastes produced during normal operation and AOOs. Adherence with the guidance of RG 1.143 provides reasonable assurance that the assigned safety classifications for structures housing the GWMS and its components comply with the requirements of GDCs 2 and 61 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 GWMS and assess the radiological impacts during postulated accidents, as noted in DSRS Sections 11.3 and BTP 11-5, and analysis of RG 1.143 in assigning the safety classifications to SSCs of the GWMS for design purposes.

9. The staff has reviewed the provisions incorporated in the applicant's design to control the release of radioactive materials in gaseous wastes from inadvertent releases, avoid the contamination of nonradioactive systems, prevent uncontrolled and unmonitored releases of radioactive materials in the environment, and avoid interconnections with nonradioactive systems, and concludes that the measures proposed by the applicant are consistent with the requirements of GDCs 60 and 61, and guidance of DC/COL-ISG-06, RG 1.143, and RG 4.21 for gaseous wastes produced during normal operation and AOOs.

10. The staff has reviewed the provisions incorporated in the applicant's design to control releases from hydrogen explosions in the GRS 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.

11. There are no specific operational programs required for the operation of the GWMS. All gaseous effluent releases associated with the operation of the GWMS are controlled by the ODCM. The applicant has committed in DSRS Section 11.5 and SRP Sections 13.4 and 13.5.1.1, 13.5.1.2, 13.5.2.1, 13.5.2.2 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 DSRS Section 11.5.

12. With respect to the consequence analysis addressing the radiological impact from an assumed waste gas system component failure or leak, the applicant has provided the results of a site-specific analysis demonstrating adherence with the acceptance criteria of DSRS Section 11.3 and BTP 11-5. If the results of a plant and site-specific analysis do not demonstrate adherence with BTP 11-5 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. Supporting information on the staff's evaluation of the site's atmospheric dispersion characteristics in transporting radioactivity into unrestricted areas is presented in SRP Section 2.3.4. The staff concludes that the analysis provided by the applicant is consistent with the guidance of BTP 11-5 and meets the dose acceptance criteria defined in BTP 11-5 for an individual located at the EAB. The applicant has considered whether the waste gas system is designed to withstand the effects of an internal hydrogen explosion and earthquakes; justified the use of special design features to mitigate the consequences of a GWMS component failure; and, if warranted, proposed TS limiting the total amount of radioactivity in components consistent with BTP 11-5 accepance criteria cannot be demonstrated using site specific information. The specific conclusions and evaluation findings of the staff will be drawn from those listed in BTP 11-5. The staff will introduce the appropriate evaluation findings and summarize the results of its independent evaluation, based on the information presented by the applicant.

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 the DC in FSAR Tier 1 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 permit conditions, 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 a permit condition for consideration in a COL application. The permit condition 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 Objective for Equipment to Control Releases of Radioactive Materials 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 52, Subpart A, "Early Site Permits."

14. 10 CFR 52.39, "Finality of early site permit determinations."

15. 10 CFR 52.47, "Contents of applications; technical information."

16. 10 CFR 52.63, "Finality of standard design certifications."

17. 10 CFR 52.80, "Contents of applications; additional technical information."

18. 10 CFR Part 100, "Reactor Site Criteria."

19. 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

20. 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.”

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

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

23. RG 1.52, “Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants.”

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

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

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

27. 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.”

28. 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.”

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

30. RG 1.111, “Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors.”

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

32. 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.”

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

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

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

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

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

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

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

40. NUREG-0017, “Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWRs) (PWR GALE Code).”

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-4653, “GASPAR II—Technical Reference and User Guide.”

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

45. 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.

46. 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).”

47. GL 99-02, “Laboratory Testing of Nuclear-Grade Activated Charcoal.”

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

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

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

51. IE Information Notice No. 82-43, “Deficiencies in LWR Air Filtration/Ventilation Systems,” November 16, 1982.

52. IE Information Notice No. 82-49, “Correction for Sample Conditions for Air and Gas Monitor,” December 16, 1982.

53. IE Information Notice No. 91-40, “Contamination of Non-Radioactive System and Resulting Possibility for Unmonitored, Uncontrolled Release to the Environment,” June 19, 1991.

54. IE Information Notice No. 99-01, “Deterioration of High-Efficiency Particulate Air Filters in a Pressurized Water Reactor Containment Fan Cooler Unit,” January 20, 1999.

55. ANSI/ANS-55.4-1993 (R2007), “Gaseous Radioactive Waste Processing Systems for Light Water Reactor Plants.” Reaffirmed in 2007.

56. ANSI/ANS-40.37-2009, “American National Standard, ~~For~~ Mobile Low-Level Radioactive Waste Processing Systems,” 2009.

57. ANSI N42.18-2004, “Specification and Performance of On Site Instrumentation for Continuously Monitoring Radioactivity in Effluents,” 2004.

58. ANSI/HPS N13.1-2011, “Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities.”

59. NUREG-0800, BTP 11-5, “Postulated Radioactive Releases Due to a Waste Gas System Leak or Failure.”

60. NEI 08-08A, “Generic FSAR Template Guidance for Life Cycle Minimization of Contamination,” Revision 0, October 2009.

61. NEI Template 07-09A, “Generic FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description,” Revision 0, March 2009.

62. NEI 97-06, “Steam Generator Program Guidelines,” 1997.

63. NUREG-0800, BTP 5-1, “Monitoring of Secondary Side Water Chemistry in PWR Steam Generators.”

64. NuScale DSRS Section 11.6, “Guidance on Instrumentation and Control Design Features for Process and Effluent Radiological Monitoring, and Area Radiation and Airborne Radioactivity Monitoring.”

65. 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 (Accession No. 102510405)