U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD for NuScale SMR DESIGN

11.5 PROCESS AND EFFLUENT RADIOLOGICAL MONITORING INSTRUMENTATION AND SAMPLING SYSTEMS

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of the effectiveness of radwaste management systems and radiation monitoring instrumentation and sampling systems.

Secondary - Organization responsible for the review of instrumentation and controls.

I. AREAS OF REVIEW

The process and effluent radiological monitoring instrumentation and sampling systems (PERMISS) of a small modular reactor (SMR) are used to monitor liquid and gaseous process streams and effluents from various plant auxiliary systems. The PERMISS includes subsystems used to collect process and effluent samples during normal operation and anticipated operational occurrences (AOOs) and under accident and post-accident conditions. Under Part 50, Appendix A, General Design Criteria (GDC) 60 and 64, the design basis of the PERMISS is important to safety in demonstrating compliance with Part 20 dose limits for workers and members of the public and shall reflect the importance of these safety functions. As such, the review of the PERMISS must be sufficient to assure that the staff has reasonable assurance that public health and safety is adequately protected.

Radiological monitoring instrumentation used to initiate control room habitability functions and, if applicable, containment isolation, are classified as safety-related. The remainder of the system is non-safety related. A part of the radiological monitoring instrumentation system serves to control radiological releases to the public, including monitoring systems that support building ventilation systems in areas housing irradiated fuel, demineralizers and filters, and waste management equipment.

The specific areas of review are as follows:

1. The design objectives and criteria for the PERMISS, including the interface with skid-mounted radiation monitoring and sampling equipment connected to permanently installed systems.

   The review identifies the (1) process and effluent streams to be monitored by radiation detection instrumentation or sampled for separate analyses, (2) purpose of each monitoring or sampling function, and (3) parameters to characterize, through monitoring instrumentation or sampling and analysis, radionuclide distributions and concentrations in sampled process and effluent streams (e.g., total gross beta-gamma or alpha activity, radionuclide-specific concentrations, isotopic, total radioactivity level, or groupings of radionuclides).

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2. The system description for the PERMISS includes:

   A. Descriptions of radiation measurement instrumentation and related sampling equipment, including redundancy and independence (where applicable); instrumentation range, calibration, and sensitivity; types of radioactive check sources installed in monitoring systems; methods for determining alarm/trip setpoints for activating alarms and terminating effluent releases or isolating processes; bases for in-plant effluent dilution; and diversity of components used for normal operations, AOOs, and postulated accidents.

   B. Location of radiation instrumentation, monitors, and direct readouts (local and control room), including the proposed locations and interface with skid-mounted radiation monitoring equipment.

   C. Location and bases of selected sampling points and sampling stations using U.S. Nuclear Regulatory Commission (NRC) and industry technical guidance in ensuring the collection of representative samples, while minimizing losses or deposition in sampling lines.

   D. Methods used to convert raw instrumentation readings into meaningful radiological results to identify radioactivity or radionuclide concentrations monitored or sampled for normal operations, AOOs, and postulated accidents in assessing radioactivity levels, concentrations, exposure rates, and doses in confirming compliance with NRC criteria and guidance.

   E. Measurements, analyses, or determinations made, including the bases for the interpretation of the results of sample analyses relying on the use of surrogate radionuclides, as easy-to-detect in accounting for the presence of hard-to-detect radionuclides when not specifically analyzed, gross beta-gamma concentrations, and via the measurements of specific radionuclides.

   F. Descriptions of instrumentation calibration methods and procedures in confirming that instrumentation response characteristics, sensitivity levels and detection limits, and detection ranges for plant-derived radionuclide distributions expected during normal operation, AOOs, and accident conditions. When two or more radiation monitoring systems are used for accident monitoring on a single discharge point, differences in instrumentation response characteristics should be described over their expected overlapping operational ranges for noble gases, fission and activation products, and radioiodines.

   G. Types and locations of annunciations and alarms and actions initiated by each type of instrumentation, and confirmation that once tripped by an alarm setpoint, the instrumentation system properly initiates and completes the expected action, such as terminating or diverting a release or process, and, if part of the design, controls in monitoring deviations of in-plant dilution and exhaust flow rates and terminating releases or isolating process flows when deviations exceed preset limits.

   H. Provisions for sample collection and analysis, including sampling lines and valves, in characterizing radionuclide concentrations in process streams and effluent

releases. Basis for the sampling and analysis program, including sample collection frequency, and types of radiological analysis, and types of sampling media consistent with the purpose and scope of operational programs. SECY-05-197 identifies the implementation of operational programs, including the elements identified in the Radiological Effluent Technical Specifications (RETS)/Standard Radiological Effluent Controls (SREC), Offsite Dose Calculation Manual (ODCM), and Radiological Environmental Monitoring Program (REMP) in a design certification (DC) or combined license (COL) application.

I. Expected relationships and interpretation of results between monitoring instrumentation readouts, sample analytical results, and plant operations against radiological criteria and regulatory limits.

J. Descriptions of procedures used for maintenance, conduct of operational functional checks (electronic and using built in sources), and inspection of monitoring instrumentation and sampling systems.

K. Layout drawings, piping and instrumentation diagrams (P&IDs), location of radiation or radioactivity monitoring instrumentation, locations of process and effluent sampling points and equipment, and locations and designations of effluent release or discharge points, and process and effluent flow diagrams.

L. Monitoring systems and procedures used for the prevention and detection of radioactivity in nonradioactive systems to prevent unmonitored and uncontrolled releases of radioactive material to the environment.

3. The scope and elements of the technical specifications (TS), RETS or SREC as they relate to the plant's ODCM, REMP, and the Process Control Program (PCP, if included). The review evaluates the bases of limiting conditions for operations and controls for operation consistent with plant design features associated with the TS and RETS/SREC, as well as procedural details and programmatic controls of the ODCM, REMP, and PCP if not included in the ODCM.

4. The quality group and safety classifications of piping and equipment and the bases governing the classification chosen in accordance with the guidance of Regulatory Guide (RG) 1.143. Design and expected temperatures and pressures and materials of construction of permanently installed systems and skid-mounted radiation monitoring and sampling equipment.

5. Design provisions incorporated in equipment and facility to ease operation and maintenance in accordance with the guidance of RG 1.143 and as referenced in topical reports, as well as previous experience with similar equipment and methods referenced in the technical submittal.

6. Design features to reduce radioactivity levels in wastes, 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 RGs 1.143 and 4.21 and Nuclear Energy Institute (NEI) Template 08-08A.

7. Design features with the means to return samples collected from process and effluents streams to their origins, and prevent sampled streams from being discharged locally or released to the environment without being monitored or treated, using the guidance of RGs 1.143 and 4.21 and NEI Template 08-08A.

8. With respect to the TS on reactor coolant system (RCS) operational leakage detection instrumentation (e.g., equivalent of TS 16.3.4.15), design features of the RCS pressure boundary leakage detection systems in reliably monitoring allowable reactor coolant leakage from RCS components contained within the containment vessel by a combination of changes in internal pressure and temperature levels, presence of steam and elevated levels of humidity, and radioactivity characterized as noble gases, fission products, and radio-iodines.

9. Design of each turbine and condenser module, including features and methods used in complying with the objectives of the TS on allowable steam generator (SG) tube leakage rates (e.g., equivalent of TS 16.3.4.13) as they relate to detection methods and sensitivities specified for radiation monitors in compliance with NRC guidance and industry standards.

10. Provisions for purging and flushing sampling lines and monitors with non-radioactive fluids (e.g., clean water, air, inert gases) and routing purged or flushed fluids to the LWMS and GWMS. Confirm that the source of non-radioactive purging or flushing fluid is protected from backflow and radioactive cross-contamination using appropriate measures, such as check valves, backflow preventers, interlocks, differential pressures, etc.

11. For multi-unit stations, descriptions and design features of equipment and components (as permanently installed systems or in combination with skid-mounted radiation monitoring equipment) normally shared between interconnected processing and waste treatment subsystems and release points. Descriptions of system services (e.g., compressed air, water, vents and drains) interfaces whenever skid-mounted radiation monitoring systems are used to augment permanently installed equipment.

12. Definition of the boundary of the LWMS, GWMS, and SWMS beginning at the interface from plant systems provided for the collection of process streams and radioactive wastes to the point of controlled discharges to the environment as defined in the ODCM or PCP at the point of recycling to primary or secondary water system storage tanks in accordance with the guidance of RG 1.143.

13. Design considerations for the use of shielding and local ventilation around portions of sampling equipment expected to exhibit elevated levels of external radiation and potential for contamination of sampling stations, placement of such equipment in shielded cubicles, and the use of temporary or permanent shielding mounted on or in the immediate vicinity of such equipment during normal operation, AOOs, and under post- accident conditions.

14. Process used to develop, review, verify, validate, and audit digital computer software used in radiation monitoring and sampling equipment, including software used to terminate or divert process and effluent streams. This aspect addresses software developed by the applicant, purchased through a vendor, or included with the instrumentation.

15. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For DC and COL reviews, the staff reviews the applicant's proposed ITAAC associated with structures, systems, and components (SSCs) related to this Design Specific Review Standard (DSRS) section in accordance with Standard Review Plan (SRP) Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this DSRS section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3. Finally, under the requirements of SECY-05-197, the implementation of operational programs, including the elements identified in the RETS/SREC, ODCM, REMP, and PCP does not necessitate ITAAC in a DC or COL application

16. 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). For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC. 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 10 of the *Code of Federal Regulations* (CFR) 52.47(a) 24) to 52.47(a)(26), 10 CFR 52.79(d)(2), and 10 CFR 52.80(a).

17. Operational Program Description and Implementation. For COL applications that include operational programs, the staff reviews the RETS/SREC, ODCM and REMP aspects of the PERMISS program description and the proposed implementation milestones. Alternatively, a COL applicant may use NEI ODCM Template 07-09A (Rev. 0, March 2009) for the purpose of meeting this regulatory milestone until a plant and site-specific operational program is made available before fuel load for NRC evaluation under the requirements of a license condition described in the final safety analysis report (FSAR, Sections 13.4 and 13.5 of the COL application). The NEI ODCM Template 07-09A has been reviewed and found acceptable by the staff (Agencywide Documents and Management System (ADAMS) Accession No. ML083530745). The staff also reviews the applicable tables in the FSAR Section 13.4 (Table 13.4) to ensure that the RETS/SREC, ODCM and REMP aspects of the Process and Effluent Monitoring and Sampling Program and associated milestones are included as license conditions.

    The review of the ODCM may be conducted as part of the review of DSRS Section 11.4, depending on whether the applicant has located the procedural details and programmatic controls in the PCP instead of the ODCM, given the provisions of Generic Letter 89-01 and NUREG-1301.

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 are as follows:

1. The review of the PERMISS, in the context of instrumentation and controls required to actuate engineered safety feature (ESF) systems designed to prevent or mitigate consequences of accidents, which could result in offsite exposures comparable to the criteria of 10 CFR, Part 100, is performed under DSRS Chapter 7, and SRP Section 13.3 (Emergency Planning), using RG 1.97. For any portion of the PERMISS (accident monitoring subsystems) that supports safety-related functions, the review addresses the performance, design, qualification, display, quality assurance (QA), and selection of monitoring variables of radiation monitoring equipment required for accident monitoring and sampling.

2. The review of provisions used for sampling during accident conditions (via the post-accident sampling system) and in controlling sample leakage, spillage, and limiting radiation exposure to workers during sampling from process waste systems and effluent streams is conducted under DSRS Section 12.3-12.4 (Radiation Protection Design Features), and SRP Sections 9.3.2 (Process and Post-accident Sampling Systems), and 13.3 (Emergency Planning), using RGs 1.21, 1.26, 1.29, 1.97 (for the identified accident monitoring variables), 1.143, and 4.21.

3. The review of the TS, as they relate to the RETS/SREC, ODCM, REMP, and PCP (if included in this section), is performed under DSRS Section 16.0, Subsection 5.0, (Administrative Controls), and SRP Sections 13.4 (Operational Programs).

4. The organization responsible for QA performs the review of design, construction, and operation phase QA programs under SRP Chapter 17. In addition, while conducting regulatory audits in accordance with Office Instruction NRR- LIC-111 or NRO-REG-108, “Regulatory Audits,” the technical staff may identify quality- related issues. If this occurs, the technical staff should contact the organization responsible for QA to determine if an inspection should be conducted.

5. The reviews of interfaces with certified standard designs and early site permits (ESPs), COL information items, and conformance with regulatory guidance (RG, SECY, regulatory issue summary (RIS), bulletins, notices, and generic letters) are performed under DSRS Section 1.0, Subsection 1.8 (COL Information Items) and Subsection 1.9 (Conformance with Regulatory Criteria and Guidance).

6. The review of the definition of the exclusion area boundary and administrative controls in managing liquid and gaseous effluent releases is performed in SRP Section 2.1.2 (Exclusion Area Authority and Control), DSRS Sections 11.2 (Liquid Waste Management System), and 11.3 (Gaseous Waste Management System).

7. The review of the bases of annual average atmospheric dispersion (X/Q) and deposition (D/Q) parameters, as used in estimating doses from noble gases, radio-iodines, carbon-14, tritium, and particulate effluents to members of the public in unrestricted areas, is

conducted under SRP Section 2.3.5 (Long-Term Atmospheric Dispersion Estimates for Routine Releases).

8. The review of the bases of expected radiological source terms, as they relate to process and effluent streams monitored by the PERMISS, is conducted under DSRS Sections 11.2, 11.3, and 11.4 (SWMS) with the basis of the source terms provided in DSRS Section 11.1 (Coolant Source Terms)

9. The review of the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena, such as the safe-shutdown earthquake, the probable maximum flood, and tornadoes and tornado missiles, is performed under SRP Sections 3.3.1 (Wind Loadings), 3.3.2 (Tornado Loadings), 3.4.2 (Analysis Procedures), 3.5.3 (Barrier Design Procedures), Section 3.7.4 (Seismic Instrumentation), DSRS Sections 3.7.1 through 3.7.3 (Seismic Design Parameters and Seismic Analysis), 3.8.4 (Other Seismic Category I Structures), and 3.8.5 (Foundations).

10. The review of the acceptability of the seismic and quality group and safety classifications for structures and system components is performed under SRP Sections 3.2.1 (Seismic Classification) and 3.2.2 (System Quality Group Classification) using RG 1.143 design criteria. 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.

11. The review of design features and instrumentation used for the protection of potable and sanitary water systems is conducted under SRP Section 9.2.1, 9.2.2, 9.2.3, 9.2.4, and 9.2.5 using RG 4.21. These systems may include potable and sanitary water systems, a demineralized water makeup system, condensate storage facilities, safety-chilled water systems, a component cooling water system, an essential service water system, a turbine cooling water system, and a seal water supply system.

12. The review of design features of auxiliary systems and interfaces with radwaste management and monitoring systems is conducted under DSRS Sections 5.4.7, 6.2.2, 6.2.4, 9.1.3, 9.3.4, 9.3.6, 10.4.7, and SRP Sections 9.2.2, 9.2.6, 9.3.2, 9.3.3, 9.4.2, 9.4.3, 9.4.4, 9.3.1, 10.4.1, 10.4.2, 10.4.3, 10.4.4, 10.4.5, and 10.4.6, using RGs 1.26, 1.29, 1.52, 1.97, 1.143, and 4.21. The systems may include the spent fuel pool cooling and cleanup system, condensate storage facilities, equipment and floor drainage system, and turbine building clean and radioactive floor and system drains.

13. The review of design features and instrumentation used for the leakage detection systems, including appropriate radiation monitoring systems, is conducted under DSRS Sections 12.3 -12.4, 5.2.5, 6.2.4, and SRP Branch Technical Position (BTP) 5-1 (Monitoring of Secondary Side Water Chemistry in Pressurized Water Reactor (PWR) Steam Generators), as they relate to detection sensitivities and detector types specified for radiation monitors provided for compliance with NEI 97-06, underlying EPRI Guidelines, and guidance of RGs 1.29 and 1.45, and RIS 2009-02 (Revision 1) and IN 2005-24.

14. The review of design features of steam and power conversion systems and interfaces with radwaste management and monitoring systems is conducted under SRP Sections 10.4.1, 10.4.2, 10.4.3, 10.4.4, 10.4.5, 10.4.6, 10.4.8 and DSRS Sections 5.4.2.1,

5.4.2.2, 10.4.7 using RGs 1.26, 1.29, and 1.143. The systems may include the main condenser evacuation system, turbine gland sealing system, condensate cleanup system, secondary-steam system chemistry, circulating water system, turbine component cooling water system, and turbine floor drains.

15. The review of design features of plant and building ventilation systems and interfaces with radwaste management and monitoring systems is conducted under SRP Sections 9.4.1, 9.4.2, 9.4.3, 9.4.4, 9.4.5 using RGs 1.13, 1.29, 1.52, and 1.140. The systems include the reactor containment vessel ventilation and treatment systems, spent-fuel pool area ventilation system, radwaste building and waste storage area ventilation systems, reactor building ventilation systems servicing radiologically controlled areas, turbine building areas ventilation system and exhaust as it relates to releases from the steam jet air ejectors, and ESF atmosphere cleanup systems as it relates to plant stack releases.

16. The review of the fire protection program and interfaces with building ventilation systems, and radiation monitoring equipment in detecting the presence of radioactivity, given the use or presence of inflammable or combustible materials (as spent resins, charcoal media, and high efficiency particulate air filters and dry wastes), is performed under SRP Sections 9.5.1.1, 9.5.1.2 and DSRS Section 11.4 using RG 1.189.

17. The review of the “as low as is reasonably achievable” (ALARA) provisions of RGs 8.8 and 8.10 in system design and operation to assure compliance with the occupational dose limits of 10 CFR 20.1201 and 10 CFR 20.1202, and Table 1 of Appendix B to 10 CFR Part 20 is conducted under SRP Section 12.1.

18. The review of design features to reduce radioactivity levels in wastes; 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 is performed in DSRS Section 12.3 -12.4 (Radiation Protection Design Features) using RGs 1.143 and 4.21 and NEI Template 08-08A in complying with the requirements of 10 CFR 20.1406.

19. For COL reviews of operational programs, the review of the applicant’s implementation plan is performed under SRP Sections 13.4, “Operational Programs,” 13.5.2.1 ”Operating and Emergency Operating Procedures,” and 13.5.2.2 “Maintenance and Other Operating Procedures.”

20. The review of design features of PERMISS subsystems and components associated with the plant’s initial testing plan, description of tests, and testing acceptance criteria is performed in SRP Section 9.3.2 (Process and Post-accident Sampling Systems, DSRS Sections 14.2 (Initial Plant Test Program), and 11.5 using RG 1.68.

21. The completeness of the description of the PERMISS design and its operational features are reviewed in SRP Section 14.3.7 (Plant Systems - Inspections, Tests, Analyses, and Acceptance Criteria) 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.

22. The review of TS, as they relate to allowable reactor coolant system (RCS) leakage rate, radiation instrumentation and sampling equipment used in monitoring allowable RCS leakage rates, primary-to-secondary steam generator tube leakage rates, and steam

generator tube integrity, are reviewed in DSRS Section 16.0 based on plant-specific information and NRC and industry guidance.

23. For portions of plant systems covered by 10 CFR Part 50, Appendix B requirements, the review of QA provisions for radiation monitoring and sampling equipment is performed using SRP Section 17.5 (Quality Assurance Program Description - Design Certification, Early Site Permit and New License Applicants). For portions of plant systems not covered by 10 CFR Part 50, Appendix B requirements, the review of design criteria is performed using RG 1.143 for process streams and waste treatment systems and industry guidance.

24. The review of the Maintenance Rule, using RG 1.160, as it relates to radiation monitoring instrumentation used to control and monitor effluent releases and radiation monitoring equipment to mitigate effluent discharges during AOOs and accidents is conducted in SRP Section 17.6 and SRP Sections 13.4, Table 13.4, Item 17.

II. ACCEPTANCE CRITERIA

Requirements

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

1. 10 CFR 20.1302 and 10 CFR 20.1301(e), as they relate to the monitoring of radioactivity in plant radiological effluents to unrestricted areas. These criteria apply to all effluent releases resulting from operation during normal plant operations and AOOs.

2. 10 CFR 50.34a, as it relates to equipment design and procedures used to control releases of radioactive material to the environment within the numerical guidance provided in Appendix I to 10 CFR Part 50.

3. 10 CFR 50.36a, as it relates to operating procedures and equipment installed in the radioactive waste system pursuant to 10 CFR 50.34a to ensure that releases of radioactive materials to unrestricted areas are kept ALARA.

4. 10 CFR 50.65(a) as it relates to providing reasonable assurance that SSCs important to safety, including those that are relied upon to mitigate accidents or transients or are used in plant emergency operating procedures (EOPs) (i.e., radiation monitors described in this section and in DSRS Section 11.6, or radiation protection features described in Section 12.3) are capable of fulfilling their intended functions.

5. 10 CFR Part 50, Appendix B, Sections XI and XII, as they relate to programs and procedures for the control of measuring and test equipment as it applies to radiation monitoring and sampling instrumentation for systems not covered by the QA guidance of RG 1.143.

6. Appendix I to 10 CFR Part 50, as it relates to numerical guides for design objectives to meet the requirements of 10 CFR 50.34a and 10 CFR 50.36a, which specify that radioactive effluents released to unrestricted areas will be kept ALARA.

7. 10 CFR 20.1406, as it relates to the design and operational procedures in minimizing contamination, facilitating eventual decommissioning, and minimizing the generation of radioactive waste.

8. 10 CFR Part 50, Appendix A, GDC 2, as it relates to the design bases of structures housing RWMS and their components using the guidance of RG 1.143 in assigning seismic and quality group classifications, and safety classifications for natural phenomena and man-induced hazards in assigning the safety classifications to SSCs of PERMISS for design purposes.

9. GDC 19 , Appendix A to 10 CFR Part 50, as it relates to actuation of systems that permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem (TEDE) for the duration of the accident.

10. GDC 60 and 61 of Appendix A to 10 CFR Part 50, as they relate to controlling effluent releases from the LWMS, GWMS, and SWMS and designing these systems to handle radioactive materials produced during normal plant operation, including operational occurrences and postulated accidents.

11. GDC 63 and 64, as they relate to designing the LWMS, GWMS, and SWMS to monitor radiation levels and radioactivity in effluents, as well as radioactive leakages and spills, during routine operation and AOOs.

12. Requirements specified in 10 CFR 50.34(f)(2)(viii), 10 CFR 50.34(f)(2)(xiv)(E), 10 CFR 50.34(f)(2)(xvii), 10 CFR 50.34(f)(2)(xxvi), and 10 CFR 50.34(f)(2)(xxvii) for monitoring gaseous effluents from all potential accident release points, consistent with the requirements of GDC 63 and 64 in minimizing exposures to members of the public. For Part 50 applicants not listed in 10 CFR 50.34(f)(2), the applicable provisions of 50.34(f)(2) will be made a requirement during the licensing process and added as a license condition, as warranted.

13. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed ITAACs that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria are met, a facility that incorporates the DC has been constructed and will be operated in conformity with the DC, the provisions of the Atomic Energy Act (AEA), and the NRC's regulations.

14. 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.

DSRS Acceptance Criteria

Specific DSRS acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are set forth below. The DSRS is not a substitute for the NRC's regulations, and compliance with it is not required. As an alternative, and as described in more detail below, an applicant may identify the differences between this DSRS section and the design features (DC and COL applications only), analytical techniques, and procedural

measures proposed in an application and discuss how the proposed alternative provides an acceptable method of complyig with the regulations that underlie the DSRS acceptance criteria, is sufficient to meet the intent of 10 CFR 52.47(a)(9), “Contents of applications; technical information.” The same approach may be used to meet the requirements of 10 CFR 52.79(a)(41) for COL applications.

1. Provisions should be made for the installation of instrumentation and monitoring equipment and/or sampling and analyses of all normal and potential effluent pathways for release of radioactive materials to the environment, including nonradioactive systems that could become radioactive through interfaces with radioactive systems. For GDC 64 and the requirements specified in 10 CFR 50.34(f)(2)(viii), 10 CFR 50.34(f)(2)(xiv)(E), 10 CFR 50.34(f)(2)(xvii), 10 CFR 50.34(f)(2)(xxvi), and 10 CFR 50.34(f)(2)(xxvii), the system designs should meet the provisions of RG 1.21 (Position C and Appendix A), and Appendix A to RG 1.33. DSRS Chapter 7 provides additional guidance on the application of RG 1.97 for any portion of the PERMISS (accident monitoring subsystems) that supports safety-related functions, as identified by the applicant.

   A. The gaseous and liquid process streams or effluent release points should be monitored and sampled according to Tables 1 and 2 of this DSRS. Other process monitoring and sampling subsystems may be added beyond those listed in either table, if not presented elsewhere in the application. Among others, such radiation monitoring subsystems may include those used on main steam lines, for RCS leakage detection in containment atmospheres, in control room air intakes, or those used for accident monitoring and sampling,

   B. Liquid waste and gaseous waste (contained in tanks) should be sampled on a batch basis before their release, in accordance with RG 1.21. Open structures, such as turbine buildings or atmospheric vents for liquid waste tanks containing treated or processed liquid waste and located outside of buildings, do not require continuous gaseous effluent monitors but the potential for releases and estimates of such releases should be evaluated and documented by other means. For liquid and gaseous effluents that cannot be easily monitored or sampled on a batch basis, one of the following representative sampling methods should be provided:

      i. Use of a continuous proportioning sampling system, with at least two sample collection tanks. The system should be designed to collect a sample at a fixed ratio established between the sample collection flow rate and the effluent stream discharge flow rate.

      ii. Use of a periodic automatic grab sampling system, with at least two sample collection tanks. The system should be designed to collect a sample at a fixed volume established at a rate that is proportional to the effluent stream discharge flow rate.

      iii. For radioactive materials, other than noble gases in gaseous effluents, a continuous sampling system should be used with replaceable particulate filters (fixed or moving) and radioiodine absorber cartridges. The system should be designed to automatically take representative samples, with minimal line or deposition losses, at a known flow rate established in accordance with American National Standards Institute/Health Physics Society (ANSI/HPS) N13.1-2011.

iv. For intermittently operating effluent release points, the system should be designed to automatically take samples whenever effluents are flowing in the discharge stream using a known ratio between discharge and sampling stream flow rates.

v. Periodic sampling and analysis frequencies and types of radiological analyses should be specified for all samples described above in the RETS/SREC, ODCM, or PCP.

2. Provisions should be made for the installation of instrumentation and monitoring equipment and/or periodic or continuous sampling and analysis of radioactive waste process systems. For GDC 60 and 63, as they relate to radioactive waste systems, detection of excessive radiation levels, and initiation of appropriate safety actions, the design of systems should meet the guidance of Appendix 11.5-A, RG 1.21 (Position C, as applicable), RG 4.15 (Position C), and Appendix A to RG 1.33. DSRS Chapter 7 provides additional guidance on the application of RG 1.97 for any portion of the PERMISS (accident monitoring subsystems) that supports safety-related functions, as identified by the applicant.

A. Provisions should be made to ensure representative sampling from radioactive process streams and tank contents. Recirculation pumps for liquid waste tanks (collection or sample test tanks) should be capable of recirculating at a rate of not less than two-tank volumes in 8 hours. For gaseous and liquid process stream samples, provisions should be made for purging sampling lines and for reducing the plate-out of radioactive materials in sample lines. Provisions for gaseous sampling from ducts and stacks should be consistent with ANSI/HPS N13.1-2011. For airborne radiation monitoring systems that rely on moving filters, the applicant should describe their intended use, (qualitative vs. quantitative applications), and the expected calibration and response time until full activity equilibrium is achieved as a function of filter paper travel rate under the radiation detector.

B. When practicable, provisions should be made to collect samples from process waste streams at central sample stations to reduce leakage, spillage, and radiation exposures to operating personnel in accordance with SRP Section 9.3.2 and 10 CFR 20.1406 using the guidance of RG 4.21 and DSRS Sections 12.3-12.4.

C. Provisions should be made to purge and drain sample streams back to the system of origin or to an appropriate waste treatment system. Purge lines should be equipped with provisions that prevent backflows and cross-contamination of non-radioactive systems supplying purging and flushing fluids. The source of non-radioactive purging or flushing fluid should be protected from backflow and radioactive cross-contamination using appropriate measures, such as check valves, backflow preventers, interlocks, differential pressures, etc.

3. Provisions should be made for administrative and procedural controls for the installation of necessary auxiliary or ancillary equipment, for the inclusion of special features in instrumentation and radiological monitoring sampling systems, and for the analysis of process and effluent streams. For GDC 63 and 64 (including the requirements specified in 10 CFR 50.34(f)(2)(viii), 10 CFR 50.34(f)(2)(xiv)(E), 10 CFR 50.34(f)(2)(xvii),

10 CFR 50.34(f)(2)(xxvi), and 10 CFR 50.34(f)(2)(xxvii)), as they relate to radioactive waste process systems and effluent discharge paths, the design of systems and the implementation of administrative and procedural controls should meet the guidance of Appendix 11.5-A, RG 1.21 (Position C), RG 4.15 (Position C), and Appendix A to RG 1.33. DSRS Chapter 7 provides additional guidance on the application of RG 1.97 for any portion of the PERMISS (accident monitoring subsystems) that supports safety-related functions, as identified by the applicant.

Instrumentation, sampling, and monitoring provisions should conform to the following:

A. Sampling frequencies, required analyses, instrument alarm/trip setpoints, calibration and sensitivities, and provisions for preparing composite samples for radioactivity analyses should conform to RGs 1.21, 1.33, and 4.15. The plant's RETS/SREC, ODCM, or PCP should indicate sampling frequencies and required analyses.

B. Provisions should be made for the necessary instrumentation and facilities to perform gross beta-gamma and gross alpha measurements, isotopic or radionuclide-specific analyses, and other routine analyses in conformance with RGs 1.21, 1.33, and 4.15.

C. Provisions should be made to perform routine instrument calibration, maintenance, and inspections in conformance with RGs 4.15 and 1.33. Instrumentation calibration procedures should consider whether instrumentation response is expected to change given that radionuclide distributions may vary with the operating status of the plant (i.e., normal operation, AOOs, accidents, and post- accident conditions). The plant's RETS/SREC, ODCM, or PCP should indicate the frequency of such actions. Provisions should also be made to replace or decontaminate instrumentation or sampling equipment without opening the process system or losing the capability of isolating the effluent stream.

D. Isolation valves, dampers, or diversion valves with automatic control features should fail in the closed or safe position. The plant's RETS/SREC, ODCM, or PCP should establish setpoints for actuation of automatic control features in initiating the timely actuation of isolation valves or dampers. The bases for establishing instrumentation alarm or system activation setpoints should be provided, taking into consideration the following:

    i. For liquid effluents, in-plant effluent dilution factors and dilution factors beyond the point of discharge to the site boundary and nearest offsite dose receptors

    ii. For gaseous and particulate effluents from plant stacks and building vents, atmospheric dispersion (χ/Q) and deposition (D/Q) factors to the site boundary and offsite dose receptors

E. Non-ESF instrumentation provisions for automatic termination or diversion of releases should conform to the design guidance contained in Appendix 11.5-A. DSRS Chapter 7 and SRP Section 13.3 address the review the ESF instrumentation provisions for automatic termination or diversion of releases using RG 1.97, and DSRS Chapter 7 as they relate to types and ranges of monitoring

variables, and qualification of radiation monitoring equipment required for accident monitoring.

F. The process used to develop, review, verify, validate, and audit digital computer software used in radiation monitoring and sampling equipment, including software used to terminate or divert process and effluent streams. This aspect addresses software developed by the applicant, purchased through a vendor, or included with the instrumentation.

4. Provisions should be made for monitoring instrumentation, sampling, and sample analyses for all identified gaseous effluent release paths in the event of a postulated accident. For GDC 64, as it relates to potential gaseous effluent release paths, the design of systems should meet the provisions of NUREG-0718, NUREG-0933, and NUREG-0737 (item II.F.1 and Attachments 1 and 2), 10 CFR 50.34(f)(2)(viii), 10 CFR 50.34(f)(2)(xiv)(E), 10 CFR 50.34(f)(2)(xvii), 10 CFR 50.34(f)(2)(xxvi), and 10 CFR 50.34(f)(2)(xxvii), Appendix 11.5-A, and RG 1.97. DSRS Chapter 7 provides additional guidance on the application of RG 1.97. For any portion of the PERMISS (accident monitoring subsystems) that supports safety-related functions, the review addresses the performance, design, qualification, display, QA, and selection of monitoring variables of radiation monitoring equipment required for accident monitoring and sampling. In addition, the design of the gaseous waste collection and processing system should meet the guidance referenced in SRP Sections 9.3.2, 13.3, and DSRS Section 11.3, as well as, the following conditions:

A. Administrative controls and procedures in conformance with Acceptance Criterion 3 of this DSRS section are to be in effect to minimize inadvertent or accidental releases of radioactive gaseous and particulate effluents.

B. Gaseous and particulate radiological effluent monitors are to be provided for the automatic termination of releases in the event that effluent release setpoints are exceeded, as provided in Acceptance Criterion 1 of this DSRS section and as established in the plant's RETS/SREC, ODCM, or PCP.

C. When two or more radiation monitoring systems are used for accident monitoring on a single discharge point, differences in instrumentation response characteristics should be described over their overlapping operational ranges for expected concentrations of noble gases, fission and activation products, and radioiodines.

5. Provisions should be made for monitoring instrumentation, sampling, and sample analysis for all identified liquid effluent release paths in the event of a postulated accident. These provisions should be in accordance with GDC 64 and the requirements of 10 CFR 50.34(f)(2)(viii), 10 CFR 50.34(f)(2)(xiv)(E), 10 CFR 50.34(f)(2)(xvii), 10 CFR 50.34(f)(2)(xxvi), and 10 CFR 50.34(f)(2)(xxvii), as they relate to postulated accidents and identified liquid effluent release paths. In addition, the design of the liquid waste collection and processing system should meet the guidance referenced in SRP Sections 9.3.2, 13.3, and DSRS 11.2, as well as, the following conditions:

A. Administrative controls and procedures in conformance with Acceptance Criteria 2 and 3 of this DSRS section are to be in effect to minimize inadvertent or accidental releases of radioactive liquids.

B. Liquid effluent radiological monitors are to be provided for the automatic termination of releases in the event that effluent release setpoints are exceeded, as provided in Acceptance Criterion 1 of this DSRS section and as established in the plant's RETS/SREC, ODCM, or PCP.

C. When two or more radiation monitoring systems are used for accident monitoring on a single discharge point, differences in instrumentation response characteristics should be described over their overlapping operational ranges for expected radionuclide distributions and concentrations.

6. Operational Programs. For COL reviews, the description of the operational program and proposed implementation milestone for the RETS/SREC, ODCM and REMP (and PCP if included) aspects of the PERMISS program are reviewed in accordance with 10 CFR 20.1301 and 20.1302, 10 CFR 50.34a, 10 CFR 50.36a, and 10 CFR Part 50, Appendix I, Sections II and IV. Its implementation is required by a license condition.

7. Descriptions of design features and instrumentation used in primary and secondary coolant system leakage detection systems should be consistent with the NEI 97-06 and underlying EPRI Guidelines, and guidance of RGs 1.29 and 1.45, and RIS 2009-02 (Revision 1) and IN 2005-24, as they relate to detection sensitivities and detector types specified for radiation monitors in demonstrating compliance with DSRS Section 16.0TS.

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 specifies, in part, that licensees conduct surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the radioactive dose limits contained in 10 CFR 20.1301 applicable to members of the public.

   This section specifies that surveys of radiation levels are conducted to demonstrate compliance with the dose limits specified in 10 CFR 20.1301. In addition, 10 CFR 20.1501 requires that surveys be conducted to demonstrate compliance with the regulations of 10 CFR Part 20. These surveys use the equipment that constitutes the process and effluent radiological monitoring instrumentation and sampling systems. RGs 1.21, 1.33, and 4.15, as well as industry standards (i.e., ANSI N42.18-2004 and ANSI/HPS N13.1-2011) provide additional guidance on measuring, evaluating, and reporting the results of radiological surveys.

   Meeting the above requirements provides reasonable assurance that the dose limits to individual members of the public specified in 10 CFR 20.1301 and 10 CFR 20.1301(e) will not be exceeded, including the dose limits of the Environmental Protection Agency (EPA) standards in 40 CFR Part 190. The review conducted in this DSRS section, with supporting information drawn from DSRS Sections 11.2, 11.3, and 11.4, evaluates the method used to demonstrate compliance with these requirements.

2. 10 CFR 50.34a specifies that an application to construct or operate a nuclear power plant describe the design of equipment installed to maintain control of radioactive materials in plant effluents produced during normal operation, including AOOs.

10 CFR 50.34a relates to DSRS Section 11.5 because processes to monitor and survey radioactive materials in liquid and gaseous effluent streams released to the environment provide crucial information for establishing controls over these effluents. As described in this DSRS section, 10 CFR 50.34a specifies the equipment used to monitor and survey effluents. 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. Compliance with these requirements is addressed separately in DSRS Section 11.2 for the LWMS, Section 11.3 for the GWMS, and Section 11.4 for the SWMS.

Meeting the requirements of 10 CFR 50.34a provides reasonable assurance that the levels of radioactivity in effluents from nuclear power plants will meet the ALARA criterion and dose objectives of Appendix I to 10 CFR Part 50. The review conducted in this DSRS section, with supporting information from DSRS Sections 11.2, 11.3, and 11.4, evaluates the method used to demonstrated compliance with these requirements.

3. 10 CFR 50.36a specifies, in part, that licenses for nuclear power reactors will include TS requiring that operating procedures be developed for the equipment specified in this regulation.

   In accordance with 10 CFR 50.36a, licensees must include TS (RETS/SREC) as part of the operating procedures related to radiological monitoring and sampling equipment and as part of the requirements for administrative controls and surveillance. The ODCM or PCP consolidate the plant's TS and related radiological effluent controls, as stated in Generic Letter 89-01 and NUREG-1301, NUREG-0133, and NUREG-0543.

   Meeting the requirements of 10 CFR 50.36a provides reasonable assurance that the levels of radioactivity in effluents from nuclear power plants will meet the ALARA criterion and result in doses to members of the public that are a small fraction of the 10 CFR 20.1301 limits. The review conducted in this DSRS section, with supporting information from DSRS Sections 11.2, 11.3, and 11.4, evaluates the method used to demonstrate compliance with these requirements.

4. Appendix I to 10 CFR Part 50 provides numerical guides for the ALARA criterion for radioactive materials released by light-water-cooled nuclear power reactors.

   10 CFR 50.34a and 10 CFR 50.36a contain provisions designed to ensure that releases of radioactive materials, as liquid and gaseous effluents, from nuclear power reactors to unrestricted areas during normal operation, including AOOs, are ALARA. Part 50, Appendix I provides specific numerical criteria and guidance for meeting this requirement.

   Meeting the requirements of the ALARA criterion provides reasonable assurance that offsite doses to any individual from normal operations and AOOs will not result in exposures in excess of the numerical guides specified in Section II of Appendix I to 10 CFR Part 50. The review conducted in this DSRS section, with supporting information drawn from DSRS Sections 11.2, 11.3, and 11.4, evaluates the method used to demonstrate compliance with these requirements.

5. Compliance with GDC 60 requires that the nuclear power plant design include mechanisms to control the release of radioactive materials in gaseous and liquid effluents

and handle radioactive solid wastes produced during normal reactor operation, including AOOs.

GDC 60 applies to DSRS Section 11.5 because mechanisms to control the release of radioactive effluents must include, among other components, equipment and related operating procedures to provide monitoring, sampling, and surveillance of effluent streams that may contain radioactive materials. RG 1.143 includes guidance on the design of radioactive waste management in protecting SSCs against natural phenomena and man-induced hazards.

Meeting the requirements of GDC 60 provides reasonable assurance that releases of radioactive materials during normal operations and AOOs will not result in offsite radiation doses that exceed the limits and design objectives specified in the regulations. The review conducted in this DSRS section, with supporting information drawn from DSRS Sections 11.2, 11.3, and 11.4, evaluates the method used to demonstrate compliance with these requirements.

6. Compliance with GDC 63 and 64 requires installation of systems to (1) monitor radioactive waste facilities for excessive radiation levels and (2) survey radioactive effluent discharge paths and the plant's environs for radioactivity released during normal operation, AOOs, and postulated accidents.

   GDC 63 and 64 relate directly to DSRS Section 11.5 because they focus on monitoring radiation levels within the plant, as well as radioactivity levels in effluent streams and plant environs, during normal operations, AOOs, and postulated accidents. The requirements specified in 10 CFR 50.34(f)(2)(viii), 10 CFR 50.34(f)(2)(xiv)(E), 10 CFR 50.34(f)(2)(xvii), 10 CFR 50.34(f)(2)(xxvi), and 10 CFR 50.34(f)(2)(xxvii) are consistent with the requirements of GDC 64. RGs 1.21, 1.33, and 4.15 provide guidance on radiological monitoring programs for normal operation and AOOs, while ANSI N42.18 -2004 and ANSI/HPS N13.1-2011 provide guidance on the selection and use of continuous radiation monitoring equipment and methods in sampling airborne radioactive materials in nuclear facilities. The RGs cited above also provide guidance on the requirements of QA programs.

   In addition to RG 4.15, the review addresses the process used to develop, review, verify, validate, and audit digital computer software used in radiation monitoring and sampling equipment, including software used to terminate or divert process and effluent streams. This aspect addresses software developed by the applicant, purchased through a vendor, or included with the instrumentation.

   Meeting the requirements of GDC 63 and 64 provides reasonable assurance that the levels of radioactivity in effluents from nuclear power plants will not exceed specified limits and design objectives. The review conducted in this DSRS section, with supporting information drawn from DSRS Sections 11.2, 11.3, and 11.4, evaluates the method used to demonstrate compliance with these requirements.

7. The requirements specified in 10 CFR 50.34(f)(2)(viii), 10 CFR 50.34(f)(2)(xiv)(E), 10 CFR 50.34(f)(2)(xvii), 10 CFR 50.34(f)(2)(xxvi), and 10 CFR 50.34(f)(2)(xxvii) include provisions for monitoring gaseous effluents from all potential accident release points.

In examining the applicant's system for sampling process streams and effluents under accident conditions, the reviewer considers RGs 1.97 and 1.101; NUREG-0933, NUREG -0737, Items II.B.3 (Clarification Items 1, 3, 6, and 11), Item II.E.4.2 (Clarification Items 2, 5, and 7 and Attachment 1), Item II.F.1, Attachment 1 on noble gas effluent monitors, III.D.1.1 (Clarification Items 1 and 3), III.D.3.3 (Clarification Items 1 to 4), and the August 16, 1982, letter from D.G. Eisenhut; SRP Section 9.3.2; and the applicant's emergency plan and implementation procedures, as described in SRP Section 13.3. For any portion of the PERMISS accident monitoring subsystems that supports safety-related functions, as identified by the applicant, the review of these design features is performed under DSRS Chapter 7 using RG 1.97. 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.
Provisions for the following should be included:

A. Purging sample lines

B. Minimizing sample loss or distortion in sample chemical and physical composition

C. Preventing blockage of sample lines

D. Appropriate tracking, storage, and disposal of samples

E. Flow restrictions or remotely operated isolation valves to limit reactor coolant loss from rupture of sample lines

The following conditions also apply:

A. Samples should be representative of reactor primary coolant, reactor steam, secondary coolant, and secondary steam in the core area or system sample streams.

B. Sample lines should be as short as possible to minimize the volume of fluid taken from containment process or effluent streams.

C. If inline monitoring is used, the design must provide backup provisions for grab sampling.

If the provisions do not address post-accident sampling, refer instead to the "Notice of Availability for Referencing in License Amendment Applications Model Safety Evaluation on Technical Specification Improvement to Eliminate Requirements on Post Accident Sampling Systems Using the Consolidated Line Item Improvement Process." Under this notice, the applicant must do the following:

A. Maintain contingency plans for obtaining and analyzing highly radioactive samples of reactor coolant, containment sump, and containment atmosphere.

B. Maintain a capability for classifying fuel damage events at the Alert Level threshold (typically at the 300 microcuries per milliliter (uCi/mL) iodine-131 dose equivalent, or about 11.1 MBq/mL).

C. Maintain the capability to monitor radioiodines that have been released to offsite environs.

8. 10 CFR 20.1301(e) requires that facilities licensed by the NRC comply with the U.S. Enviromental Protection Agency's (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 millisievert (mSv) (25 millirem (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, external radiation exposures from buildings, storage tanks, and radioactive waste storage areas. The EPA standards apply to the entire site or facility, which may have either single or multiple units. DSRS Sections 11.2, 11.3, and 11.4 address sources of radioactivity and doses associated with liquid and gaseous effluents and solid wastes. DSRS Section 12.3-12.4 addresses sources of radiation and external radiation exposures from buildings, storage tanks, and radioactive waste storage areas. NUREG-0543 presents information and guidance in demonstrating compliance with the EPA standards.

For COL applicants with site-specific information on the locations of offsite dose receptors, compliance with the EPA standards requires consideration of whether doses due to 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.

9. 10 CFR 50.65(a) requires the implementation of a program to monitor the effectiveness of maintenance of SSCs important to safety, including those that are relied upon to mitigate plant AOOs, transients, and accidents.

In examining the applicant's monitoring program, the review applies the guidance of RG 1.160 as it relates to the maintenance of PERMISS subsystems that are important to the protection of public health and safety. The evaluation of the maintenance program should consider subsystems that include radiation monitoring equipment, as described in this DSRS section, radiation protection features described in DSRS Section 12.3-12.4, and those that are used in plant emergency operating procedures. The review should confirm that the radiation monitoring equipment and their use in the context of emergency procedures provide the means of fulfilling their intended functions and can be relied upon to mitigate AOOs, transients, or accidents.

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 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.

The information describing the design features of the PERMISS provided in the DC application, the update of the FSAR, or the COL application to the extent not addressed in a referenced certified design, including referenced sections of DSRS Sections 11.1, 11.2, 11.3, 11.4, and 12.3-12.4, is reviewed for completeness in accordance with RG 1.70 or 1.206.

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 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. In accordance with 10 CFR 52.47(a)(8), (21), and (22), and 10 CFR 52.79(a)(17), (20), and (37), for DC or COL applications submitted under 10 CFR Part 52, the applicant is required to (1) address the proposed technical resolution of unresolved safety issues and medium and high priority generic safety issues which are identified in the version of NUREG 0933, "Resolution of Generic Safety Issues," current on the date up to 6 months before the docket date of the application and which are technically relevant to the design, (2) demonstrate how the operating experience insights have been incorporated into the plant design, and (3) provide information necessary to demonstrate compliance with any technically relevant portions of the Three Mile Island requirements set forth in 10 CFR 50.34(f), except paragraphs (f)(1)(xii), (f)(2)(ix), and (f)(3)(v), for a DC application, and except paragraphs (f)(1)(xii), (f)(2)(ix), (f)(2)(xxv), and (f)(3)(v),for a COL application. These cross cutting review areas should be addressed by the reviewer for each technical subsection and relevant conclusions documented in the corresponding safety evaluation report (SER) section.

3. In the review of the PERMISS, the reviewer compares the listing of process and effluent monitors contained in the application with the principal release points identified in DSRS Sections 11.2 to 11.4 to ensure that all major process streams and release pathways are being monitored during normal operation, AOOs, and postulated accidents. The comparison will include radiation monitoring systems that are used for plant safety and protection, monitoring plant operation (including the operation of the LWMS, GWMS, and SWMS), monitoring and controlling liquid and gaseous effluent releases to unrestricted areas, and instrumentation used for monitoring intersystem leakage among plant subsystems. In addition, the review addresses the monitoring of nonradioactive systems that could become contaminated with radioactivity through interfaces with radioactive systems. At a minimum, the review includes the following:

   A. The types and numbers of instruments, number of instrumentation channels, and location of detectors, sampling points, and process and effluent sampling stations. The bases for the selection of these sampling or monitoring points are compared with the general principles and criteria for obtaining valid samples of radioactive materials from liquid and gaseous process and effluent streams. The review also considers the methods and materials used in gaseous and particulate sampling equipment and the guidance for sampling from ducts and stacks contained in RG 4.15, and industry guidance of ANSI N42.18-2004, and ANSI/HPS N13.1-2011.

   B. To ensure representative sampling, the review compares equipment design features, layout, piping, and description of sampling methods to the guidance in RGs 1.21, 1.143, and 4.15, and industry guidance of ANSI N42.18-2004 and ANSI/HPS N13.1-2011.

   C. The review includes an independent evaluation of radioactivity levels and radionuclide concentrations in process and effluent streams using the models of DSRS Section 11.1, NUREG-0017 and RG 1.112 (as modified) to confirm estimates of expected radiation or radioactivity levels during normal operations

and AOOs. 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.

D. For non-safety related systems, the review of interfaces of radiation monitoring instrumentation and controls, including provisions for automatic control features and interdependence with sensing elements other than radioactivity (e.g., fluid level, valve position, and system pressure, flow rate, and temperature), is performed using the guidance presented in this DSRS section and DSRS Section 11.6, RG 1.21 and 4.15, ANSI N42.18-2004, and Appendix 11.5-A to this DSRS section. Depending on specific design features and types of automatic control features, the staff's evaluation initiated under this DSRS section may involve complementary reviews of other systems in considering component interfaces, such as instrumentation and controls, electrical power distribution to valve and damper actuators, provisions in flushing and purging sampling lines, and system engineering (e.g., balance of plant systems and ventilation systems servicing ambient areas of the plant containing radioactive materials and collecting offgases from system and component vents. In ensuring compliance with regulations, 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 instrumentation, functional interdependence and logic in alarming and terminating or diverting process or effluent streams: (1) in complying with doses for members of the public, (2) in complying with effluent concentration limits under 10 CFR Part 20, and (3) before exceeding design objectives of Appendix I to 10 CFR Part 50. The review and evaluation of instrumentation used for the protection of plant workers are addressed in DSRS Sections 12.3-12.4, 12.5, and SRP Section 13.3. The review also considers design features that would prevent radioactive contamination of otherwise non-radioactive plant systems, and unmonitored and uncontrolled releases of radioactive materials in the environment. The reviewer will determine whether the design and operational features of the PERMISS comply with NRC regulations, are consistent with NRC and industry guidance on radiation monitoring and sampling, and confirm that the acceptance criteria of DSRS Section 11.6 have been met.

E. For safety related functions assigned to portions of PERMISS' accident monitoring functions, the reviewer compares and evaluates design features, performance, design, qualification, display, QA, and selection of monitoring variables of radiation monitoring equipment required for accident monitoring and sampling under DSRS Chapter 7 and SRP Section 13.3 using the guidance of RG 1.97.

F. In the review of the P&IDs for the liquid and gaseous waste treatment systems, the reviewer verifies that specifically identified radioactive release points have provisions for automatic termination or diversion of releases in the event that they exceed a predetermined alarm level. The reviewer compares the provisions for instrumentation with automatic termination of releases to the design guidance in Appendix 11.5-A.

G. The reviewer evaluates the location of the radiation monitors, collocated sampling points, shown on the P&IDs and placements of readouts and annunciation panels,

and alarms discussed in design control document (DCD) or application of DSRS Chapter 7 to ensure that plant operators will be advised of system performance and instrumentation responses for effluent release rates or concentrations in assessing compliance with release limits specified in the plant's RETS/SREC and ODCM or PCP.

H. The reviewer compares the proposed calibration methods (i.e., electronic and via the use of the National Institute of Standards and Technology traceable radioactive standards) and frequency of calibrations with the guidance in RGs 1.21, 1.33, and 4.15. The review of instrumentation calibrations considers whether instrumentation response is expected to change given that radionuclide distributions may vary with the operating status of the plant (i.e., normal operation, AOOs, and during accident and post-accident conditions).

I. The reviewer confirms that adequate documentation exists to confirm the verification and validation of digital computer software used in radiation monitoring and sampling equipment, including software used to terminate or divert process and effluent streams. This evaluation includes software developed by the applicant, purchased through a vendor, or included with the instrumentation.

J. The reviewer ensures that the design allows detectors to be replaced or decontaminated without opening the boundary of the process system or without losing the capability to isolate the system or divert effluents to tanks or standby treatment systems (as appropriate).

K. The reviewer evaluates, on a case-by-case basis, the use of special system design features or reliance on applicable topical reports, as well as data referenced in the application that are applied as technical bases beyond the NRC guidance.

4. The reviewer evaluates programs and procedures described in the applicant's proposed RETS/SREC, REMP, ODCM or PCP (if included) for the PERMISS. The reviewer determines that the applicant's RETS/SREC, REMP, ODCM, or PCP meet the requirements of 10 CFR 50.34a and 10 CFR 50.36a; the Appendix I to 10 CFR Part 50 dose objectives for maximally exposed offsite individual doses (Section II); Sections III and IV of Appendix I to 10 CFR Part 50 regarding the implementation of Appendix I criteria; effluent concentration limits and Note 4 unity criterion of Appendix B (Table 2) to 10 CFR Part 20; and dose limits of 10 CFR 20.1301 and 20.1302 for members of the public, and 10 CFR 20.1301(e) for assessing total dose from all sources of radioactivity and radiation. For applications that refer to the NEI ODCM Template 07-09A (Revision 0, March 2009) in complying with this regulatory milestone, no other review of the RETS/SREC, REMP, and ODCM programs is necessary under this DSRS section since the NEI ODCM Template 07-09A has been reviewed and found acceptable by the staff (ML083530745). Instead, the staff reviews Section 13.4 of the technical submittal to ensure that the RETS/SREC, REMP, and ODCM are included as license conditions for the development of a plant and site-specific program before fuel load.

For plant and site-specific RETS/SREC, REMP, and ODCM or PCP programs, the format and content of the RETS/SREC, ODCM, REMP, or PCP should be consistent with the requirements of Generic Letter 89-01 and the guidance of NUREG-1301 and NUREG -0133, Radiological Assessment BTP (Revision 1, November 1979), and

RGs 1.21, 1.33, 4.1, 4.8, and 4.15. The review includes the evaluation of the following operational documents:

A. RETS/SREC—Review of the TS (i.e., administrative controls section) proposed by the applicant for process and effluent control is performed for input to the review of DSRS Section 16.0 and in this DSRS section for the RETS/SREC. The reviewer determines that the elements and scope of the programs identified in the administrative controls section of the TS agree with the requirements identified as a result of the staff's review. The review includes the evaluation or development of appropriate limiting conditions for operation or controls and their bases, consistent with the plant design. For the RETS/SREC, the review determines whether the following elements are addressed and that they meet regulatory requirements and guidance noted above for liquid and gaseous effluents. The review addresses surveillance requirements and controls; operational conditions of radiation monitoring and sampling equipment; required number of operational channels; conduct and frequencies of channel checks, source checks, channel calibrations, and channel functional checks; compliance with action statements and remediation whenever the number of operational channels and applicability are less than the required minimum; sampling and analysis programs for continuous and batch mode releases, including provisions for the collection of grab and composite samples; and derivations of the lower limit of detections by categories of effluents or radionuclides and types of radiological analyses. The programs identified in the administrative controls section of the TS and elements of the RETS/SREC are reviewed using the provisions of Generic Letter 89-01 and NUREG-1301.

B. ODCM—The ODCM is reviewed to determine whether descriptions of the methodology and parameters used for calculating offsite doses to members of the public, resulting from gaseous and liquid effluent releases, meet the regulatory requirements and guidance noted above. The procedural details and programmatic elements of the ODCM should be based on the guidance of NUREG-1301, NUREG-0133, and NUREG-0543. The ODCM should describe the methods used to calculate doses in accordance with the guidance of RGs 1.109 and 1.111 or 1.113 using appropriate computer codes (e.g., LADTAP II (NUREG/CR-4013) and GASPAR II (NUREG/CR-4653)).

The ODCM should (1) identify all liquid and gaseous effluent release points and the types and locations of installed radiological instrumentation used to monitor and control effluent releases, (2) describe parameters and provide justification of values used to derive effluent release rates and alarm setpoints, including the bases of dilution factors for liquid effluents (in-plant and beyond the point of release) and atmospheric dispersion (X/Q) and deposition (D/Q) factors for gaseous and particulate effluents, (3) provide specifications for maximum radioactivity levels in tanks containing liquids and descriptions of protective measures applied to spills and leaks from such tanks, (4) identify locations of offsite dose receptors and the basis for their selection using the results of annual land use census surveys, (5) describe criteria used to determine the operability of waste treatment systems and requirements in conducting dose projections, such as whenever treatment systems are not fully utilized, or in assessing monthly, quarterly, and yearly doses, and (6) define administrative and operational procedures associated with the implementation of the ODCM.

For sites with applicants and licensees operating two or more reactors, each applicant and licensee should include in their respective ODCM a process for notifying other licensees on the same site to ensure that, when combined, effluent concentrations and offsite doses and dose rate limits of Part 20 are not exceeded. The operation of two or more plants will be contributing to and sharing a single dose allocation for members of the public under 10 CFR 20.1301 and 10 CFR 20.1302; 10 CFR 20.1301(e) in complying with 40 CFR Part 190; and the unity-rule in meeting liquid and gaseous effluent concentration limits and Note 4 unity criterion of 10 CFR Part 20, Appendix B, Table 2, Columns 1 and 2. The notification process should include a means by which releases of liquid and gaseous effluents can be coordinated and controlled such that all licensees on the site are jointly aware of routine and planned releases, and those associated with AOOs as they occur. The review should confirm that each applicant and licensee has acknowledged the need for such arrangements and that commitments have been made to formalize such arrangements in their respective ODCMs and implementing procedures.

The review evaluates the description of programs and procedures addressing QA and quality control supporting the implementation of the ODCM, the description of information to be contained in annual radiological effluent release reports, the listing of requirements mandating reports to the NRC, and the process for initiating and documenting changes to the ODCM and its supporting procedures.

The review of the ODCM may be conducted as part of the review of DSRS Section 11.4, depending on where the applicant has located the procedural details and programmatic controls of the ODCM in the PCP, given the provisions of Generic Letter 89-01 and NUREG-1301.

C. REMP—The REMP is reviewed to determine whether the program provides the means to monitor and quantify radiation and radioactivity levels in the environs of the plant associated with gaseous and liquid effluent releases and the direct external radiation from contained sources of radioactive materials in tanks and equipment and in buildings. The REMP demonstrates compliance with the regulatory requirements and guidance noted above. The procedural details and programmatic elements of the REMP should be based on the guidance of NUREG-1301, Radiological Assessment BTP (Revision 1, November 1979), and RGs 1.21, 4.1, 4.8, and 4.15.

The REMP should describe a process and methods for monitoring, sampling, and analyzing environmental samples representative of expected radionuclide distributions and concentrations in environmental media and associated exposure pathways. The REMP should identify the type, number, sampling locations, sample volume or weight, and sampling and analytical frequencies of environmental samples. The types of samples should include cow or goat milk and milk products, surface and ground water, fish and invertebrates, meat and poultry and meat products, fruits and vegetables, leafy vegetables, grains, other local food products, sediments and soils, and air. The selection of sampling locations and types of samples, including control sample locations, should be based on the results of a yearly land use census to ensure that changes in exposure pathways are identified and that modifications are made to the

monitoring program to reflect such changes. In assessing direct external radiation exposures, the REMP should identify sources of radiation and radioactivity, such as tanks and equipment and waste storage buildings and spent-fuel storage; types of measurement methods used at each location; and locations of monitoring stations around plant facilities, including those used to monitor nearest dose receptors. The REMP should define the detection limits and reporting levels for all expected radionuclides and environmental samples and external radiation monitoring methods. The review evaluates information describing participation in an inter-laboratory comparison program to assess the precision and accuracy of measurements of radioactivity in environmental samples as part of the QA program.

The review of the REMP evaluates (1) administrative and operational procedures associated with its implementation, (2) descriptions of programs and procedures addressing QA and quality control supporting its implementation, (3) description of information to be contained in annual radiological environmental operating reports, (4) listing of requirements mandating reports to the NRC, and (5) process for initiating and documenting changes to the REMP and its supporting procedures.

The review of the REMP is conducted as part of the review of this DSRS section, depending on where the applicant has located the procedural details and programmatic controls of the REMP in the ODCM and/or PCP, given the provisions of Generic Letter 89-01 and NUREG-1301.

D. PCP—The PCP and associated plant TS are reviewed to determine whether they identify all regulatory requirements, follow NRC guidance, and contain all appropriate operational elements. The review of the PCP may be conducted as part of the review of DSRS Section 11.4 or as part of the review of this DSRS section, depending on where the applicant has located the procedural details and programmatic controls of the PCP, given the provisions of Generic Letter 89-01 and NUREG-1301. DSRS Section 11.4 addresses the review and evaluation of the PCP and identifies the regulatory requirements associated with the handling, processing (e.g., dewatering, solidification, and compaction), characterization, packaging, and shipment of radioactive wastes to authorized low-level waste disposal sites or licensed waste processors.

5. To the extent not covered in DSRS Sections 11.2 and 11.3, the design of sampling components and sample tanks and their placement in buildings should include provisions to reduce leakage and facilitate operations and maintenance. The design and layout should be compared to the guidance of RG 4.21 and RG 1.143 for liquid wastes and venting of tanks and components. RG 1.143 describes design guidance acceptable to the NRC staff related to seismic, safety, and quality group classifications and QA provisions for LWMS and GWMS subsystems and components. Compliance with RG 1.143 provides reasonable assurance that the assigned safety classifications for structures housing the LWMS and GWMS and their components comply with the requirements of GDC 2 and 61 for natural phenomena and man-induced hazards.

6. For liquid and gaseous process radiation monitoring equipment not covered by the ODCM, the review should confirm that the applicant, even when referencing a DC, provides information describing methods and procedures that will be used in deriving lower limits of detection or detection sensitivities, and set-points (alarms and process

termination/diversion) for process radiation monitoring equipment. Similarly, the applicant is responsible for developing a plant-specific process and radiological sampling and analysis plan for systems not covered by the ODCM, including provisions describing sampling and analytical frequencies, and radiological analyses for the expected types of liquid and gaseous samples and waste media generated by the LWMS, GWMS, and SWMS. The review should confirm that the proposed sampling and analytical frequencies, and radiological analyses are commensurate with expected levels of radioactivity in associated systems. The review should also confirm that procedurally, the results of such radiological analyses would be integrated in plant procedures used to assess the performance of process and effluent treatment systems.

7. For an applicant that references a DC and that chooses to install and operate skid-mounted radiation monitoring and sampling systems connected to permanently installed radioactive process and waste management systems, the review should determine whether the applicant has provided sufficient plant-specific information describing how the design and operating features are integrated with the PERMISS. The review should also address the requirements of 10 CFR Part 20.1406 and guidance of RGs 4.21 and 1.143, IE Bulletin 80-10, ANSI/HPS-13.1-2011 and ANSI N42.18-2004, and NEI 08-08A.

8. For process instrumentation and method used to quantify reactor coolant system leakage and leakage rates, and steam generator tube integrity and leakage rate, the technical review should, in part, be based on the plant's TS, as described in the applicable sections of DSRS Section 16.0(TS), 5.2.5 and SRP Section 10.4.8. To the extent not covered in SRP Section 10.4.8, DSRS Sections 5.2.5, and 12.3-12.4, the review will assess whether the design incorporates NRC and industry guidance, including BTP 5-1, RG 1.45, IN 2005-24, 2007-20, and 2009-02 (Revision 1); and NEI 97-06 and EPRI Reports No. 1013420, 1008224, and 1008219. NRC and industry guidance describes and establishes acceptable means by which to satisfy radiation monitor sensitivity requirements for leakage detection increases over specified time periods, using a realistic primary coolant concentration, and primary to secondary leakage through any one steam generator. The evaluation should consider descriptions of radiation monitors used to satisfy TS, specify minimum radiation monitor sensitivities given the bases of RCS and steam generator tube leakage rates in TS for the DC, indicate whether noble gas radiation monitors will be used to supplement the containment particulate radiation monitor, and provide descriptions of models, methods, and assumptions used in calculations supporting the stated radiation monitor sensitivity levels and compliance with TS.

9. For each containment vessel, the review will evaluate the capability of the evacuation system to maintain negative pressure within the containment vessel, whether the evacuation system will be operating in a continuous or intermittent mode, connection of each evacuation systems to an appropriate treatment system (gaseous and liquid for condensates), and radiation monitoring prior to directing the exhaust to the plant stack, with the presence of steam and elevated levels of humidity and radioactivity as noble gases, fission products, and radio-iodines, and plate-out of particulate radionuclides on internal surfaces of the containment vessel. To the extent not covered in DSRS Sections 5.2.5, 11.2, 11.3, 11.5, 11.6, and 12.3-12.4, the review will address the placement of radiation detectors and sampling lines, types of detectors and detection sensitivities, selection of radionuclides forming the basis of instrumentation responses, assumed primary coolant concentrations in deriving detection sensitivity thresholds in complying with technical specifications, and placement of radiation detectors in plant locations with low ambient external radiation levels to maximize instrumentation response times.

10. Given that the design does not include a SG blowdown and treatment system, the review will consider the capability of the condensate polishing demineralizers to collect, remove, and direct fission products (e.g., radio-iodines, noble gases, and other non-condensable gases) from the secondary side in the event of SG tube failures. The review will evaluate design features to collect main condenser evacuation system (MCES) and turbine gland sealing system (TGSS) exhausts for processing and monitoring. The review will consider necessary interfaces with liquid and gaseous waste management systems, decay heat removal system heat exchangers, feedwater condensate storage tanks, and radiation monitoring systems in avoiding uncontrolled and unmonitored releases to the environment and cross-contamination of non-radioactive systems. NRC requirements and NRC and industry guidance are provided in Part 10 CFR 20.1406, DSRS Sections 5.4.2, 10.4.8, 11.2, 11.3, 11.4, and 12.3-12.4, and Branch Technical Position (BTP) 5-1 (Monitoring of Secondary Side Water Chemistry in Pressurized Water Reactor (PWR) Steam Generators), Regulatory Guide 4.2, and NEI 08-08A.

11. The review of the design of each turbine and condenser module should determine whether the design features are based on existing NRC and industry guidance or rely on alternate methods in complying with the objectives of the TS on SG tube leakage rates (e.g., equivalent of TS 16.3.4.13). Current NRC and industry guidance is provided in DSRS Sections 5.4.2, 10.4.8, 11.2, 11.3, and 12.3-12.4, and SRP Branch Technical Position (BTP) 5-1 (Monitoring of Secondary Side Water Chemistry in Pressurized Water Reactor (PWR) Steam Generators), as they relate to detection sensitivities and detector types specified for radiation monitors provided for compliance with NEI 97-06, underlying EPRI Guidelines, and guidance of RGs 1.29 and 1.45, and RIS 2009-02 (Revision 1) and IN 2005-24.

12. The PERMISS is reviewed to ensure that the design includes provisions to prevent and collect leakage and spillage associated with sample collection, processing, storage, and operation of skid-mounted monitoring and sampling equipment that conform to the guidance of RG 1.143 and 4.21 under the requirements of 10 CFR 20.1406.

    The review should confirm whether design features are included to return samples collected from process and effluents streams to their origins, and prevent sampled streams from being discharged locally or released to the environment without being treated and monitored using the guidance of RG 1.143 and 4.21 and NEI Template 08 -08A. The review should evaluate provisions in purging and flushing sampling lines and monitors with non-radioactive fluids (e.g., clean water, air, inert gases) and route purged or flushed fluids to the LWMS and GWMS. In addition, the review should confirm that the source of non-radioactive purging or flushing fluid is protected from radioactive cross-contamination using appropriate measures, such as check valves, backflow preventers, interlocks, differential pressures, etc.

    The review considers information describing design 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 extraneous radioactive wastes associated with the operation of the PERMISS as a result of operator error and processing equipment failures or malfunctions. In addition, the review may also consider the information contained in the DC application, the update in the FSAR, or the COL application to the extent not addressed in a referenced certified design.

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

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

B. DSRS Sections 5.2.4, 9.3.4, 9.3.6, 9.4, 10.4.7, 11.2, 11.3, 11.4, and 12.3 - 12.4, SRP Sections 5.2.1.1, 5.2.1.2, 5.2.2, 5.2.3, 5.2.5, 9.2.1-7, 9.3.1, 9.3.2, 9.3.3, 9.4.1-5, 10.4.1-6, 10.4.8.

C. Relevant NRC bulletins, circulars, and notices (e.g., Inspection and Enforcement (IE) Bulletin No. 80-10; IE Circular Nos. 77-14, 79-21, and 81-09; IE Information Notice Nos. 79-07, 79-09, 86-42, 86-43, 91-40, 2004-05, 2006-13, and 2012 -05; and Regulatory Issue Summary 2008-03. As part of the review process, the staff should identify and point out technical and regulatory issues to applicants as they develop the design of specific systems and operational programs in ensuring that prior NRC issues identified in past IN, I&E, circulars, and RIS have been adequately considered in the application.); and Regulatory Issue Summary 2008-03.

D. Industry guidance and standards, e.g., NEI 08-08A, American Nuclear Society (ANS) N42.18-2004, ANSI/ANS-55.6-1993 (R2007), ANSI/ANS-55.4-1993 (R2007), and ANSI/ANS-40.37-2009.

13. In determining compliance with the EPA generally applicable environmental radiation standards of 40 CFR Part 190, as implemented under 10 CFR 20.1301(e), the review confirms that the ODCM includes the appropriate methodology to account for all sources of radiation and radioactivity as potential contributors to doses to members of the public from the site, which may have either single or multiple units. The review focuses on methods used to assess the total dose from sources of radioactivity, external radiation exposures from waste processing buildings, waste storage buildings, waste storage tanks, and temporary waste storage or staging areas, and spent-fuel storage. The source terms and associated doses from liquid and gaseous effluents associated with the operation of the LWMS, GWMS, and SWMS are evaluated under DSRS Sections 11.2, 11.3, and 11.4. Doses associated with external radiation from buildings and sources of radioactivity contained in systems and components are evaluated under DSRS Section 12.3-12.4.

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. In 10 CFR 50.65(a)(1), the NRC requires that applicants and licensees monitor the performance or condition of SSCs against licensee-established goals in a manner sufficient to provide reasonable assurance that such SSCs are capable of fulfilling their intended functions. In addition, good maintenance is also important in ensuring that failure of other than safety-related SSCs that could initiate or adversely affect a transient or accident is minimized, including those that are relied upon to mitigate accidents or transients or are used in plant EOPs (i.e., radiation monitors described in this section, or radiation protection features described in DSRS Section 12.3). The evalution should confirm that the applicant, in its maintenance program, will monitor the operation and performance of radiation monitoring and sampling systems, including the implementation of a corrective action program, in desmonstrating that such systems are capable of performing their intended functions.-.

15. Operational Programs. The reviewer verifies that the RETS/SREC, ODCM and REMP aspects of the Process and Effluent Monitoring and Sampling Program are fully described and that implementation milestones have been identified. The reviewer verifies that the program and implementation milestones are included in FSAR Table 13.4. The implementation of the RETS/SREC, ODCM and REMP aspects of the Process and Effluent Monitoring and Sampling Program is included in the license condition for operational programs. Under the standards established by SECY -05 -197, the implementation of operational programs, including the elements identified in the RETS/SREC, ODCM, REMP, and PCP does not necessitate ITAAC in a DC or COL application.

    The reviewer should determine whether the evaluation of the ODCM needs to be conducted as part of the review of DSRS Section 11.4 in instances when the applicant has located the procedural details and programmatic controls in the PCP instead of the ODCM, given the provisions of Generic Letter 89-01 and NUREG-1301.

    Implementation of this program will be inspected in accordance with NRC Inspection Manual Chapter IMC-2504, “Construction Inspection Program - Inspection of Construction and Operational Programs.”

16. For 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 DCD meets the 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 DCD.

    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).

    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 review 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.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following types to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The staff concludes that the designs of the PERMISS (as permanently installed systems or in combination with skid-mounted systems) include the equipment necessary to monitor process and effluent streams and control releases of radioactive materials associated with the operation of the LWMS, GWMS, and SWMS. The designs are found to be acceptable and meet the applicable requirements of 10 CFR 20.1301 and 20.1302, 10 CFR 20.1301(e), and 10 CFR 20.1406; 10 CFR 50.34a, 10 CFR 50.36a, 10 CFR 50.34(f)(2)(viii), 10 CFR 50.34(f)(2)(xiv)(E), 10 CFR 50.34(f)(2)(xvii), 10 CFR 50.34(f)(2)(xxvi), and 10 CFR 50.34(f)(2)(xxvii); 10 CFR Part 50 Appendix I dose objectives; and GDC 2, 19, 60, 61, 63, and 64.

This conclusion is based on the following:

1. With respect to the operational features of the PERMISS, the applicant has included instrumentation for monitoring and sampling radioactivity for contaminated liquid, gaseous, and solid waste process and effluent streams. The staff evaluated the provisions proposed to sample and monitor all appropriate process streams and effluent release points, including nonradioactive systems that could become contaminated through interfaces with radioactive systems, in accordance with GDC 64 and the requirements specified in 10 CFR 50.34(f)(2)(viii), 10 CFR 50.34(f)(2)(xiv)(E),10 CFR 50.34(f)(2)(xvii), 10 CFR 50.34(f)(2)(xxvi), and 10 CFR 50.34(f)(2)(xxvii).

2. With respect to the operational features of the PERMISS, the applicant has included provisions for automatic termination of effluent releases and ensures control over discharges in accordance with GDC 60. The provisions proposed for sampling and monitoring liquid, gaseous, and solid waste process streams, under the PCP, are in accordance with GDC 63. The provisions for sampling process and effluent streams and conducting analysis of samples, including the proposed analytical programs, are in accordance with the guidance in RGs 1.21, 1.33, 4.1, 4.8, and 4.15 for routine plant operation and AOOs for liquid, wet, and solid wastes.

3. With respect to the design and operational features of the PERMISS, the applicant provided sufficient information describing the types, numbers, and placement of radiation monitoring and sampling equipment in plant systems, operational ranges and qualification of radiation detectors in supporting the functions of radiation monitoring subsystems, functional interdependence and logic in alarming and terminating or diverting process or effluent streams in complying with doses for members of the public and effluent concentration limits under 10 CFR Part 20, and before exceeding design objectives of Appendix I to 10 CFR Part 50. The staff concludes that the information describing the design and operational features of the PERMISS complies with NRC

regulations, is consistent with NRC and industry guidance on radiation monitoring and sampling, and confirms that the acceptance criteria of DSRS Section 11.6 have been met. Supporting information on the staff's evaluation of the applicant's information is presented in this DSRS section, DSRS Chapter 7, as applicable, DSRS Section 11.6. The staff will introduce the appropriate evaluation findings here, based on the staff's evaluation conducted under DSRS Section 11.6.

4. Under the requirements of 10 CFR 50.34(f)(2) on TMI-related technical topics, the applicant has included provisions for sampling and monitoring process and effluent streams and conducting analysis of samples, including the proposed analytical programs, during postulated accidents and were found to be in accordance with the requirements of 10 CFR 50.34(f)(2)(viii), 10 CFR 50.34(f)(2)(xiv)(E), 10 CFR 50.34(f)(2)(xvii), 10 CFR 50.34(f)(2)(xxvi), and 10 CFR 50.34(f)(2)(xxvii), and the guidance in RG 1.97 and Appendix 11.5-A, as supported by the reviews and evaluations conducted under SRP Section 13.3 and DSRS Chapter 7. The applicant identified the specific revision of RG 1.97 applicable to the application, as described in DSRS Chapter 7. Supporting information on the staff's evaluation and findings of the applicant's information is presented in DSRS Chapters 7 and DSRS Sections 12.3-12.4, 12.5, and SRP Section 13.3 and is summarized here as necessary.

5. The review evaluated P&IDs, process flow diagrams, and descriptions of system proposed sampling points for the liquid, gaseous, and solid waste systems, provisions for local ventilation, and locations of monitoring and sampling points relative to effluent release points, as shown on site plot diagrams.

6. The staff reviewed the applicant's QA provisions for the PERMISS, the quality group and safety classifications used for system components, and the seismic design applied to structures housing these systems. As described by the applicant, the design of the systems and structures housing these systems has met the guidance of RG 1.143 in protecting against natural phenomena and man-induced hazards. Compliance with RG 1.143 provides reasonable assurance that the assigned safety classifications for structures housing the RWMS and their components comply with the requirements of GDC 2 and 61 for natural phenomena and man-induced hazards in assigning the safety classifications to SSCs of RWMS for design purposes. The elements of the QA program are consistent with the NRC guidance contained in

   RGs 1.21, 1.33, 4.1, 4.8, and 4.15; Generic Letter 89-01; Radiological Assessment BTP (Revision 1, November 1979); and NUREG-1301 and NUREG-0133.

7. The staff reviewed the provisions incorporated in the applicant's design to (1) control the release of radioactive materials in wastes and effluents caused by spills, leaks, and inadvertent tank overflows, (2) avoid the contamination of nonradioactive systems, (3) prevent uncontrolled and unmonitored releases of radioactive materials in the environment, and (4) avoid interconnections with potable and sanitary water systems. On the basis of this review, the staff concludes that the applicant's proposed measures are consistent with the guidance of RGs 1.143 and 4.21 given the requirements of GDC 60 and 64.

8. The staff concludes that the RETS/SREC, ODCM or PCP, and REMP describing administrative programs and operational procedures associated with their

implementation are consistent with the requirements of Generic Letter 89-01 and Radiological Assessment BTP (Revision 1, November 1979), and the guidance of NUREG-1301, NUREG-0543, and NUREG-0133, and RGs 1.21, 1.33, 4.1, 4.8, and 4.15.

9. For liquid and gaseous process radiation monitoring equipment not covered by the ODCM, the review confirmed that the applicant has provided sufficient information describing methods and procedures that will be used in deriving lower limits of detection or detection sensitivities, and set-points (alarms and process termination/diversion) for process radiation monitoring equipment. Similarly, the applicant has provided information describing a plant-specific process and radiological sampling and analysis plan for systems not covered by the ODCM. These provisions describe sampling and analytical frequencies, and radiological analyses for the expected types of liquid and gaseous samples and waste media generated by the LWMS, GWMS, and SWMS. The review confirmed that the proposed sampling and analytical frequencies, and radiological analyses are commensurate with expected levels of radioactivity in associated systems.

10. The staff reviews the sources of radiation and radioactivity and associated doses to members of the public and concludes that the total annual dose from all sources of radioactivity and radiation from the site, which may have either single or multiple units, including liquid and gaseous effluents, external radiation exposures from buildings and storage tanks, and spent-fuel, 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 20.1301(e).

11. The staff reviews the application to determine that the applicant met the requirements of 10 CFR 20.1406 with respect to describing how the 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.

12. In accordance with the requirements of 10 CFR 50.65(a), consistent with the guidance provided in RG 1.160, procedures are provided to monitor the performance or condition of SSCs, including those that are relied upon to mitigate accidents or transients or are used in plant EOPs, against licensee-established goals in a manner sufficient to provide reasonable assurance that SSCs important to safety, including those that are relied upon to mitigate accidents or transients or are used in plant EOPs (i.e., radiation monitors described in this section and in DSRS Section 11.6 or radiation protection features described in Section 12.3) are capable of fulfilling their intended functions.

13. The staff has reviewed the application and determined that the applicant described the RETS/SREC, ODCM and REMP aspects of the Process and Effluent Monitoring and Sampling Program and its implementation which is included in the license condition on operational programs and implementation.

14. The applicant described the [specify applicable operational program] and its implementation in conformance with [specify applicable regulation]. [For program implementation not specified by regulations, the staff will add a statement indicating that

the program(s) and its implementation milestones are included within the license condition on operational program implementation.]

15. 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.

    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.

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 Part 20, "Standards for Protection Against Radiation."

2. 10 CFR 20.1101(b), "Radiation Protection Programs," as it relates to ALARA provisions in controlling doses to members of the public.

3. 10 CFR 20.1201, "Occupational Dose Limits for Adults."

4. 10 CFR 20.1202, "Compliance with Requirements for Summation of External and Internal Doses."

5. 10 CFR 20.1301, "Dose Limits for Individual Members of the Public."

6. 10 CFR 20.1301(e), "Dose Limits for Individual Members of the Public," as it relates to compliance with EPA's 40 CFR Part 190 generally applicable environmental radiation standards for facilities within the nuclear fuel cycle.

7. 10 CFR 20.1302, "Compliance with Dose Limits for Individual Members of the Public."

8. 10 CFR 20.1406, "Minimization of Contamination."

9. 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."

10. 10 CFR Part 50.34, "Contents of Applications; Technical Information," as it relates to the means for controlling and monitoring releases of radioactive materials expected during operations, AOOs, and accident conditions in compliance with the limits of 10 CFR 20.1301 and 20.1302 for members of the public.

11. 10 CFR 50.34a, "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents—Nuclear Power Plants."

12. 10 CFR 50.34(f)(2)(viii), 10 CFR 50.34(f)(2)(xiv)(E), 10 CFR 50.34(f)(2)(xvii), 10 CFR 50.34(f)(2)(xxvi), and 10 CFR 50.34(f)(2)(xxvii), under "Additional TMI-Related Requirements" as they relate to provisions in monitoring, sampling, and terminating effluent releases under accident conditions.

13. 10 CFR 50.36a, "Technical Specifications on Effluents from Nuclear Power Reactors."

14. 10 CFR Part 50, Appendix A, GDC 2, “Design bases for protection against natural phenomena.”

15. 10 CFR Part 50, Appendix A, GDC 19, “Control Room.”

16. 10 CFR Part 50, Appendix A, GDC 60, “Control of Releases of Radioactive Materials to the Environment.”

17. 10 CFR Part 50, Appendix A, GDC 61, “Fuel Storage and Handling and Radioactivity Control,”

18. 10 CFR Part 50, Appendix A, GDC 63, “Monitoring Fuel and Waste Storage.”

19. 10 CFR Part 50, Appendix A, GDC 64, “Monitoring Radioactivity Releases.”

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

21. 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.”

22. 10 CFR Part 52, “Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants.”

23. 10 CFR Part 100, “Reactor Site Criteria.”

24. Generic Letter 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),” January 31, 1989.

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

26. RG 1.21, “Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants.”

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

28. RG 1.45, “Guidance on Monitoring and Responding to Reactor Coolant System Leakage.”

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

30. RG 1.70, “Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition).”

31. 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.”

32. 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.”

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

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

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

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

37. RG 1.160, “Monitoring the Effectiveness of Maintenance at Nuclear Power Plants.” This regulatory guide supersedes RG 1.182, May 2000.

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

39. RG 4.1, “Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants.”

40. RG 4.8, “Environmental Technical Specifications for Nuclear Power Plants.”

41. RG 4.15, “Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination)—Effluent Streams and the Environment.”

42. RG 4.15, “Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment.”

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

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

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

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

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

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

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

50. NUREG-0543, “Methods for Demonstrating LWR Compliance With the EPA Uranium Fuel Cycle Standard (40 CFR Part 190).”

51. NUREG-0718, “Licensing Requirements for Pending Applications for Construction Permits and Manufacturing Licenses.”

52. NUREG-0737, “Clarification of TMI Action Plan Requirements,” 1980.

53. NUREG-0933, “Resolution of Generic Safety Issues (Formerly entitled "A Prioritization of Generic Safety Issues," December 2011.

54. NUREG-1301, “Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors.” [This NUREG includes Generic Letter 89-01.]

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

56. NUREG/CR-4013, “LADTAP II – Technical Reference and User Guide,” April 1986.

57. NUREG/CR-4653, GASPAR II – Technical Reference and User Guide,” March 1987.

58. NRC Inspection Manual Chapter IMC-2504, “Construction Inspection Program - Inspection of Construction and Operational Programs,” issued October 3, 2007.

59. Radiological Assessment Branch Technical Position, Revision 1, November 1979.

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

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

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

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

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

65. IE Information Notice No. 86-42, “Improper Maintenance of Radiation Monitoring Systems,” June 9, 1986.

66. IE Information Notice No. 86-43, “Problems with Silver Zeolite Sampling of Airborne Radioiodine,” June 10, 1986.

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

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

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

70. Information Notice 2005-24, “Nonconservatism in Leakage Detection Sensitivity,” August 3, 2005.

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

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

73. RIS 2008-03, “Return/Re-use of Previously Discharged Radioactive Effluents,” February 13, 2008.

74. RIS 2007-20, “Implementation of Primary-to-Secondary Leakage Performance Criteria,” August 23, 2007.

75. RIS 2009-02, “Use of Containment Atmosphere Gaseous Radioactivity Monitors as Reactor Coolant System Leakage Detection Equipment at Nuclear Power Reactors,” January 29, 2009 with Rev. 1 issued May 8, 2009.

76. Memorandum from D.G. Eisenhut, NRR, to Regional Administrators, August 16, 1982, “Proposed Guidance for Calibration and Surveillance Requirements for Equipment Provided to Meet Item II.F.1, Attachments 1, 2, and 3, NUREG-0737,” with enclosures.

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79. NEI, “Generic FSAR Template Guidance for Life Cycle Minimization of Contamination,” NEI 08-08A (Revision 0, October 2009). The template includes the NRC’s Safety Evaluation Report and acceptance finding.

80. NEI, “Industry Ground Water Protection Initiative – Final Guidance Document” NEI 07-07, August 2007.

81. NEI, “Steam Generator Program Guidelines” NEI 97-06, Rev. 3, January 2011.

82. Technical Specifications Task Force, “TSTF-513 - Revised PWR Operability Requirements and Actions for RCS Leakage Instrumentation, Rev. 1, February 18, 2009.

83. Technical Specifications Task Force, “TSTF-449 – Steam Generator Tube Integrity,” Rev. 4, April 14, 2005.

84. EPRI, “PWR Secondary Water Chemistry Guidelines: Draft Revision 6,” Report 1008224, December 2004.

85. EPRI, “PWR Primary-to-Secondary Leak Guidelines: Revision 3,” Report 1008219, December 2004.

86. EPRI, “Pressurized Water Reactor Primary Water Zinc Application Guidelines,” Report 1013420, 2006.

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

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

89. ANSI/ANS-55.6-1993 (R2007), “Liquid Radioactive Waste Processing System for Light Water Reactor Plants.” Reaffirmed in 2007.

90. NuScaleTM Design Specific Review Standard, Section 11.6, “Guidance on Instrumentation and Control Design Features for Process and Effluent Radiological Monitoring, and Area Radiation and Airborne Radioactivity Monitoring.”

91. 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)

TABLE 1

Provisions for Monitoring and Sampling Gaseous Process and Waste Streams(*)

		Monitor Provisions			Sample Provisions		
		In Process	In Effluent		In Process	In Effluent	
No.	Process Systems	Cont[i]	ACF[j]	Cont[i]	Grab[k]	Grab[k]	Cont[l]
1.	Waste Offgas Holdup System[a]	NG	NG	(NG)		(NG,H3)	(I)
2.	Condenser Evacuation System[b]	NG	(NG)[n]	(NG)	I	(NG,H3)	(I)
3.	Vent & Stack Release Point System[c]	–	–	NG		H3	(I)
4.	Containment isolation systems[d]	NG	NG[m]	(NG)	I	(NG,I,H3)	(I)
5.	Service Building Ventilation System	_	_	(NG)	I	(NG,H3)	(I)
6.	Fuel Storage Area Ventilation System[e]	(NG)	NG[m]	(NG)	I	(NG,H3)	(I)
7.	Radwaste Area Vent Systems	_	_	(NG)	I	(NG,H3)	(I)
8.	Turbine Gland Seal Condenser Vent System	_	_	(NG)	I	(NG,H3)	(I)
9.	Mech. Vacuum Pump Exhaust (Hogging System)			(NG)	I	(NG,H3)	(I)
10.	Containment evacuation system	(R)	(NG)	NG	I	(NG,H3)	(I)
11.	Pretreatment Liquid Radwaste Tank Vent Gas Systems	_	_	(NG)	(I)	(NG,H3)	(I)
12.	Residual heat removal system	(R)	(NG)	NG	I	(NG,H3)	I
13.	Turbine Building Area Vent	_	_	(NG)	I	(NG,H3)	(I)
14.	Chemical and Volume Control System Vents	_	_	(NG)	I	(NG,H3)	(I)
15.	Waste compactors, shredders, etc. (as permanently installed or mobile systems)	R	–	I	I	I	(I)
16.	Exhausts from Compressed Air Systems with Potential for Radioactive Cross-contamination	R	–	I	I	I	(I)

(*) For key to legend, see notes on page following Table 2.

TABLE 2

Provisions for Monitoring and Sampling Liquid Process and Waste Streams (*)

No.	Process Systems	Monitor Provisions			Sample Provisions		
		In Process	In Effluent		In Process	In Effluent	
		Cont[i]	ACF[j]	Cont[i]	Grab[k]	Grab[k]	Cont[i]
1.	Liquid Radwaste (Batch) Treatment and Effluent System	(R)	R	R	S&A	S&A,H3	—
2.	Liquid Radwaste (Continuous) Treatment and Effluent System	R	R	R	—	S&A,H3	S&A
3.	Service Water System, Circulating Water System, Turbine Cooling Water System, Demin. Water Makeup System, etc. (as systems with potential for radioactive cross-contamination)	—	—	(R)	—	S&A,H3	S&A
4.	Component Cooling Water System [f]	(R)	(R^m)	(R)	S&A	S&A,H3	(S&A)
5.	Spent Fuel Pool Treatment System [g]	(R)	(R)	(R)	S&A	(S&A,H3)	(S&A)
6.	Equipment & Floor Drain Collection and Treatment Systems [h]	—	(R)	(R)	—	(S&A,H3)	(S&A)
7.	Phase Separator Decant & Holding Basin Systems	—	(R)	(R)	—	(S&A,H3)	(S&A)
8.	Containment evacuation system		(R)	(R)		(S&A,H3)	(S&A)
9.	Laboratory & Sample System Waste Systems	—	(R)	(R)	S&A	(S&A,H3)	(S&A)
10.	Laundry & Decontamination Waste Systems	—	(R)	(R)	—	(S&A,H3)	(S&A)
11.	Resin Slurry, Solidification, & Drain Systems	(R)	—	(R)	—	(S&A,H3)	(S&A)
12.	Radwaste Liquid Tanks (if located outside of buildings)	—	—	(R)	S&A	(S&A,H3)	—
13.	Site storm & Underdrain Water Systems	—	—	—	—	(S&A,H3)	(S&A)
14.	Tanks and Sumps Inside Reactor and Radwaste Building	—	(R)	(R)	—	(S&A,H3)	(S&A)
15.	CVCS and boron recovery system (as associated with process treatment and liquid effluents)	—	(R)	(R)	—	(S&A,H3)	(S&A)
16.	Containment heat removal		(R)	(R)		(S&A,H3)	(S&A)
17.	Containment isolation system		(R)	(R)	—	(S&A,H3)	(S&A)
18.	Secondary Coolant Treatment Waste & Turbine Building Drain Systems	—	(R)	(R)	—	(S&A,H3)	(S&A)

19.	Noncontaminated Wastewater & PWR Turbine Building Clean Drain System	—	—	—	—	(S&A,H3)	(S&A)
20.	Other process and effluent treatment systems, e.g., electro-deionization, UV/Ozone destruction (if mixed wastes are possible), reverse osmosis, ultra-filtration, centrifugal separation, etc.	R	R	R	S&A	S&A,H3	S&A
21.	Mobile Liquid and Wet Waste Processing Systems (as described by applicant or licensee.)	R	R	R	S&A	S&A,H3	S&A
22.	Reactor coolant pressure boundary and steam generator tube TS leakage rate monitoring systems	R1	--	R1	S&A	--	--

(*) For key to legend, see notes on next page.

Notes for Table 1 and Table 2

a - For example, offgas storage tank systems, cover gas decay systems, chilled charcoal adsorption systems, offgas cryogenic units, and noble gas delay beds and tanks.

b - For example, main condenser steam jet air ejector systems and mechanical vacuum pump systems.

c - For example, free standing stacks, roof vents, building vents, system exhausters, process vents, ventilation vents, and portable local exhaust ventilation systems.

d - For example, reacor vessel purges prior to refueling, and reactor containment vessel leak testing.

e - Includes spent fuel pool and refueling pool ventilation systems, if separate from the fuel storage area ventilation system.

f - Also called closed cooling water systems and component cooling loop systems.

g - Includes refueling pool cleanup systems.

h - Includes suppression tanks, reactor drain tanks, equipment and drain sumps collecting leakage, drainage, sampling, and condensate.

i - Continuous radiation monitor.

j - Automatic control feature. For example, the continuous liquid effluent radiation monitor (see note m, below) should be equipped to alarm at a setpoint established in the RETS/SREC, or ODCM and should automatically terminate effluents in the discharge line by closing an isolation valve (see DSRS Acceptance Criterion 3.D).

k - Sample point should be available to obtain grab samples for laboratory analyses as indicated by notations or for the purpose of confirming the results of continuous radiation monitoring.

l - Continuous sampler (see DSRS Acceptance Criterion 1.B).

m - The automatic control feature may be alternatively provided by a process continuous radiation monitor located at a point upstream of the systems' effluent continuous radiation monitor to ensure the timely closure of the isolation valve/damper before exceeding discharge limits. If part of the design, controls in monitoring deviations of in-plant dilution and exhaust flow rates in terminating releases or isolating process flows when deviations exceed preset limits. These provisions apply to liquid and gaseous process radiation monitoring equipment not covered by the ODCM,

NG - Noble gas radioactivity, such as argon, krypton, and xenon gases.

I - Iodine radioactivity, fission and activation products, and radioactivity of other radionuclides in particulate and gaseous form (e.g., carbon-14), and alpha emitters.

H3 - Tritium as tritiated water and water vapors, and elemental and organic forms.

R - Gross radioactivity (beta radiation, gamma radiation, or total beta plus gamma). This provision also applies to measurement methods relying on the use of surrogate radionuclides, as easy-to-detect, in accounting for the presence of hard-to-detect radionuclides when not specifically analyzed or monitored.

R1 - For instrumentation used to comply with Tech. Specs (TS) on reactor coolant pressure boundary (RCPB) or steam generator (SG) tube leakage rates, the basis of the placement of the radiation detectors on system piping and components and detection sensitivity of the radiation monitoring system should be described and specify which radionuclides are used to demonstrate compliance with the TS.

S&A - Sampling and analysis of radionuclides, including gross radioactivity, identification and concentration of principal or significant radionuclides, and concentration of alpha emitters, as defined in the RETS/SREC and ODCM using NRC guidance. This provision applies to liquid and gaseous process radiation monitoring equipment not covered by the ODCM, including information describing a plant-specific process, Tech. Specs for RCPB and SG tube leakage rates, and radiological sampling and analysis plan for systems not covered by the ODCM.

( ) - Monitoring or sampling provisions indicated within parentheses are required only for systems not monitored, sampled, or analyzed (as indicated) prior to release.

APPENDIX 11.5-A

DESIGN GUIDANCE FOR RADIOLOGICAL EFFLUENT MONITORS PROVIDING SIGNALS FOR INITIATING TERMINATION OF FLOW OR OTHER MODIFICATION OF EFFLUENT STREAM PROPERTIES

1. Background

The primary design function of a radiological effluent monitor is the detection and measurement of radioactive materials released in gaseous or liquid effluent streams of light-water-cooled nuclear power reactors. An additional design function of some monitors is to provide a signal to automatically terminate or otherwise modify the effluent stream. Examples of this function are the termination and closure of an isolation valve based on a liquid effluent monitor interlock in the radwaste management system, on a liquid effluent discharge to the environment.Depending on plant design and onsite meteorology, such an action may be necessary to mitigate the consequences of a design-basis accident (DBA). The need for such mitigation is determined by calculating the offsite doses that would result from the DBA. In other plant designs, radiological effluent monitors are used to actuate systems to modify or terminate releases for other purposes (e.g., to terminate releases from AOOs occurrences to ensure that offsite doses are maintained within the limits specified in the plant TS and radiological effluent controls (RETS or SREC) and ODCM.

The design and quality assurance (QA) criteria applied to the design, procurement, installation, testing, and operation of radiological effluent monitors installed in light-water-cooled nuclear power reactors should provide assurance that the monitors will perform all of their design safety functions using the guidance of DSRS Chapters 7 and SRP Chapter 13 and RG 1.97 for safety related systems.

If the design basis accident (DBA) analysis indicates that the actuation of an ESF system is required to mitigate the consequences of a DBA and a signal from a radiological effluent monitor is necessary to actuate the ESF system, then the monitor should be designed and qualified to the design and QA criteria applicable to the ESF system. Conversely, if an automatically functioning device or system is used to reduce radioactive releases to ensure that offsite doses are maintained within the limits of the plant's RETS/SREC (i.e., not for the purpose of mitigating the consequences of a DBA), then a monitor providing the actuation signal should be designed and qualified to criteria consistent with those of the actuated system, such as those that are important to safety.

For non-safety related systems, the review of interfaces of radiation monitoring instrumentation and controls, including provisions for automatic control features and interdependence with sensing elements other than radioactivity (e.g., fluid level, valve position, and system pressure, flow rate, and temperature), is performed using the guidance presented in this section and DSRS Section 11.6. 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 instrumentation, functional interdependence and logic in alarming and terminating or diverting process or effluent streams in complying with doses for workers, 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 the radioactive contamination of otherwise non-radioactive plant systems, and in avoiding unmonitored and uncontrolled releases of radioactive materials in the environment.

This appendix neither establishes, nor changes in any manner, the design and QA criteria established elsewhere for ESF or ESF-related systems or monitors.

The design guidance set forth in this appendix provides reasonable assurance that monitors used to provide initiation signals for actuation of systems to control the release of radioactive materials in effluents, but not required to mitigate the consequences of a DBA, are designed, constructed, installed, tested, and maintained on a level commensurate with their intended safety function.

This appendix sets forth minimum requirements and is not intended to prohibit the implementation of equivalent design codes, standards, or QA measures other than those indicated herein.

2. Definitions

Radiological Effluent Monitor: A device that removes a representative sample from the effluent stream, detects and quantitatively measures the radioactive materials present in the sample, discharges the sampled medium back to the effluent stream, and transmits the measurement data to a central point. Some monitoring systems instead rely on the placement of a radiation detector near or within the effluent streams in achieving the same function without diverting any portion of the effluent stream.

Monitoring System: A system consisting of one or more remote monitors; a centrally located cabinet or console where data from the monitors are received, recorded, converted to meaningful radiological units, and displayed; and the necessary interconnecting cables, power supplies, pumps, motors, alarms, recorders, display panels, and other auxiliary components.

Automatic Control Feature: A design feature that automatically initiates a control or protective action when exceeding a defined instrumentation alarm set-point. The set point may represent radioactivity concentration levels and release rates, or signals other than radioactivity (e.g., fluid level, valve position, and system pressure, flow rate, and temperature). The initiation of control or protective actions may rely only the presence of radioactivity or be linked to the status other plant system parameters as functional interdependence and logic in alarming and terminating or diverting process or effluent streams.

3. Design Guidance

Design and QA criteria for radiological effluent monitors should be consistent with the design and QA criteria applicable to the systems actuated by a signal from the monitors.

Monitors providing signals for the actuation of ESF systems should be designed and qualified to the design and QA criteria applicable to ESF systems. Criteria for ESF-related monitors are found in the appropriate sections of DSRS Chapter 7. This position does not affect or modify existing criteria for ESF-related systems.

Monitors providing signals for the actuation of non-ESF systems should be designed and qualified to the design and QA criteria applicable to the actuated system or to the criteria shown in Table 1 of this appendix and guidance of this DSRS section.

4. Implementation

This section provides information to applicants and licensees regarding the staff's plans for using this appendix.

Except in those cases in which the applicant proposes an alternate method for complying with specified portions of the Commission's regulations, the criteria described herein will be used to evaluate applications for construction permits, operating licenses, standard DCs and COLs.

These criteria do not apply to operating plants.

TABLE 1

Design Guidance for Radiological Effluent Monitors
(Instrumentation Installed in Light-Water-Cooled Nuclear Power Plants)

Category	Design Criteria	Quality Assurance Criteria, and Quality Group and Safety Classifications
Effluent radiological monitoring instrumentation providing a signal for the actuation of a system used to control or reduce releases of radioactive materials in effluents within limits specified in the plant's RETS/SREC. (Not required to initiate actuation for an ESF system. For safety related systems, see DSRS Chapter 7, DSRS Section 11.6, and RG 1.97 for guidance.)	Review: Reviewed under DSRS Sections 11.5 and 11.6.	Review: Reviewed under DSRS Sections 11.5, 11.6, and SRP Chapter 17.
	Reviewed by: 1, 2, 3, & 4.	Reviewed by: 2, 3, 4, and 5.
	Criteria: Manufacturer's per standard ANSI N42.18-2004. Criteria: Quality assurance set forth in RG 1.143, Section IV Safety Classification: RG 1.143, Reg. Positions C.5 and C.6 in protecting systems and equipment against natural phenomena and man-induced hazards.	Reviewed by:1, 2, 3, and 5 Reviewed by:1, 2, 3, and 5 Reviewed by: 1 , 2, 3, and 6.

Notes:
1. Organization responsible for the review and assessment of the performance of the process and effluent radiological instrumentation and sampling systems and associated RETS or SREC, including the Offsite Dose Calculation Manual and/or the Process Control Program.
2. Organization responsible for the review of system specifications and plant systems interface elements of the process and effluent radiological instrumentation and sampling systems, including system functional performance.
3. Organization responsible for the review of the instrumentation and controls elements of the process and effluent radiological instrumentation and sampling systems, including system functional performance.
4. Organization responsible for the review of emergency planning.
5. Organization responsible for the review of quality assurance.
6. Organizations responsible for the reviews of SSCs quality group and safety classifications under SRP Sections 3.2.1, 3.2.2 and DSRS Sections 11.2 to 11.6 using the guidance of RG 1.143.

APPENDIX 11.5-B

NuScale DSRS Chapter 11
Review Procedures on Unique Design Features

Reactor Module

In addition to the above review steps, the review of each reactor module will encompass the following technical areas:

1. For each containment vessel, the review will evaluate the capability of the evacuation system to maintain negative pressure within the containment vessel, whether the evacuation system will be operating in a continuous or intermittent mode, connection of each evacuation systems to an appropriate treatment system, and radiation monitoring prior to directing the exhaust to the plant stack.
2. RCS operational leakage rates (e.g., equivalent of TS 16.3.4.13), the review should determine whether the design features are based on existing NRC and industry guidance or rely on alternate methods in complying with the objectives of the TS. Current NRC and industry guidance is provided in DSRS Sections 5.2.5, 11.2, 11.5, and 12.3-12.4, as they relate to detection sensitivities and detector types specified for radiation monitors given the guidance of RG 1.29 and 1.45, and RIS 2009-02 (Revision 1) and IN 2005-24.

3. and presence of steam and elevated levels of humidity and radioactivity as noble gases, fission products, and radio-iodines. To the extent not covered in DSRS Sections 5.2.5, 11.2, 11.5, 11.6, and 12.3-12.4, the review will address the placement of radiation detectors and sampling lines, types of detectors and detection sensitivities, selection of radionuclides forming the basis of instrumentation responses, assumed primary coolant concentrations in deriving detection sensitivity thresholds in complying with technical specifications, and placement of radiation detectors in plant locations with low ambient external radiation levels to maximize instrumentation response times.

4. In addressing the preparation and transfer of each reactor module to the refueling pool, the review should consider design features that will isolate any open portions of the primary and secondary coolant systems in minimizing the contamination of reactor pool water and ambient atmosphere within the reactor building. In minimizing the transfer of contamination, the description of design features should specify which ones are part of the design, those that are temporary and would be installed to containment vessel components before each transfer, and necessary interfaces with liquid and gaseous waste management systems.

5. With respect to the immersion of the reactor module in the reactor pool, the review will address production mechanism and concentration of neutron activation products in reactor pool water. With respect to neutron activation products, the review will consider reactions associated with thermal and fast neutrons, expected neutron flux density in zones enveloping each containment vessel, target elements present in reactor pool water (e.g., specs on boron concentrations and demineralizer water quality), and equilibrium concentrations of activated radionuclides and their decay chain products. For longer-lived activation products, the review will consider whether the design includes processing equipment, such as liquid and gaseous waste management systems, that will be used to reduce their concentrations in reactor pool water and ambient atmosphere of the reactor building.

6. In a parallel concern, the review will address whether neutron activation of the secondary coolant is possible given the close proximity of feedwater nozzle plenums to the top of the reactor core. With respect to neutron activation products, the review will consider reactions associated with thermal and fast neutrons, expected neutron flux density at representative locations, target elements present in demineralizer water, and equilibrium concentrations of neutron activated radionuclides and their decay chain products. For longer-lived activation products, the review will consider whether the design includes processing equipment, e.g., condensate polishing system, can reduce their concentrations in feedwater. If neutron activation products are expected in feedwater, the evaluation will consider operational and regulatory implications of the presence of this form of radioactivity, in addition to those associated with steam generator tube failures, in the secondary coolant, condenser, condenser evacuation system, condensate demineralizer, turbine building equipment and floor drains, and associated releases to the environment.

Steam Generator and Turbine/Condenser Module

17. In addition to the above review steps, the review of each steam generator and turbine and condenser module will encompass the following technical areas:Given that the design does not include a SG blowdown and treatment system, the review will consider the capability of the condensate polishing demineralizers to remove fission products (except for NG) from the secondary side in the event of SG tube failures. The review will evaluate design features to collect MCES and TGSS exhausts for processing and monitoring, transfer and collection of spent resins for processing, packaging, and storage, and collect and route turbine building floor and equipment drains to the radwaste building or waste a handling facility located within the turbine building for all condenser/turbine modules.NRC requirements and NRC and industry guidance are provided in 10 CFR 20.1406, SRP Section 10.4.8, DSRS Sections 5.4.2.1, 5.4.2.2, 11.2, 11.3, 11.5Current NRC and industry guidance is provided inSRP Section 10.4.8, DSRS Sections 5.4.2.1, 5.4.2.2, 11.2, 11.3, 11.5, and 12.3-12.4, and Branch Technical Position (BTP) 5-1 (Monitoring of Secondary Side Water Chemistry in Pressurized Water Reactor (PWR) Steam Generators), as they relate to detection sensitivities and detector types specified for radiation monitors provided for compliance with NEI 97-06, underlying EPRI Guidelines, and guidance of RGs 1.29 and 1.45, and RIS 2009-02 (Revision 1) and IN 2005-24.

18. With respect to the TS on SG operational leakage detection instrumentation (e.g., equivalent of TS 16.3.4.15), the review should determine whether the SG tube leakage detection systems can reliably monitor the presence of fission products in secondary coolant in the event of SG tube failures. To the extent not covered in DSRS Sections 5.4.2.1, 5.4.2.2, 11.3, 11.5, 11.6, and 12.3-12.4, the review will address the placement of radiation detectors, types of detectors and detection sensitivities, selection of radionuclides forming the basis of instrumentation responses, assumed secondary coolant concentrations in deriving detection sensitivity thresholds in complying with technical specifications, and placement of radiation detectors in plant locations with low ambient external radiation levels to maximize instrumentation response times.

APPENDIX 11.5-C

NuScale DSRS Chapter 11
Review Procedures on Unique Design Features

Containment Module

In addition to the above review steps, the review of each reactor module will encompass the following technical areas:

1. For each containment vessel, the review will evaluate the capability of the evacuation system to maintain negative pressure within the containment vessel, whether the evacuation system will be operating in a continuous or intermittent mode, connection of each evacuation systems to an appropriate treatment system, and radiation monitoring prior to directing the exhaust to the plant stack.

2. With respect to the TS on RCS operational leakage rates (e.g., equivalent of TS 16.3.4.13), the review should determine whether the design features are based on existing NRC and industry guidance or rely on alternate methods in complying with the objectives of the TS. Current NRC and industry guidance is provided in DSRS Sections 5.2.5, 11.2, 11.5, and 12.3-12.4, as they relate to detection sensitivities and detector types specified for radiation monitors given the guidance of RG 1.29 and 1.45, and RIS 2009-02 (Revision 1) and IN 2005-24.

3. With respect to the TS on RCS operational leakage detection instrumentation (e.g., equivalent of TS 16.3.4.15), the review should determine whether the RCS pressure boundary leakage detection systems can reliably monitor reactor coolant leakage from RCS components and contained within the containment vessel by a combination of changes in internal pressure and temperature levels, and presence of steam and elevated levels of humidity and radioactivity as noble gases, fission products, and radio-iodines. To the extent not covered in DSRS Sections 5.2.5, 11.2, 11.5, 11.6, and 12.3-12.4, the review will address the placement of radiation detectors and sampling lines, types of detectors and detection sensitivities, selection of radionuclides forming the basis of instrumentation responses, assumed primary coolant concentrations in deriving detection sensitivity thresholds in complying with technical specifications, and placement of radiation detectors in plant locations with low ambient external radiation levels to maximize instrumentation response times. The review should consider which leakage detection component is the primary leakage detection method, and the ability of the secondary leakage detection instruments to perform their leakage detection functions when the primary method is inoperable.

4. In addressing the preparation and transfer of each reactor module to the refueling pool, the review should consider design features that will isolate any open portions of the primary and secondary coolant systems in minimizing the contamination of reactor pool water and ambient atmosphere within the reactor building. In minimizing the transfer of contamination, the description of design features should specify which ones are part of the design, those that are temporary and would be installed to containment vessel components before each transfer, and necessary interfaces with liquid and gaseous waste management systems.

5. With respect to the immersion of the reactor module in the reactor pool, the review will address production mechanism and concentration of neutron activation products in reactor

pool water. With respect to neutron activation products, the review will consider reactions associated with thermal and fast neutrons, expected neutron flux density in zones enveloping each containment vessel, target elements present in reactor pool water (e.g., specs on boron concentrations and demineralizer water quality), and equilibrium concentrations of activated radionuclides and their decay chain products. For longer-lived activation products, the review will consider whether the design includes processing equipment, such as liquid and gaseous waste management systems, that will be used to reduce their concentrations in reactor pool water and ambient atmosphere of the reactor building.

6. In a parallel concern, the review will address whether neutron activation of the secondary coolant is possible given the close proximity of feedwater nozzle plenums to the top of the reactor core. With respect to neutron activation products, the review will consider reactions associated with thermal and fast neutrons, expected neutron flux density at representative locations, target elements present in demineralizer water, and equilibrium concentrations of neutron activated radionuclides and their decay chain products. For longer-lived activation products, the review will consider whether the design includes processing equipment, e.g., condensate polishing system, can reduce their concentrations in feedwater. If neutron activation products are expected in feedwater, the evaluation will consider operational and regulatory implications of the presence of this form of radioactivity, in addition to those associated with steam generator tube failures, in the secondary coolant, condenser, condenser evacuation system, condensate demineralizer, turbine building equipment and floor drains, and associated releases to the environment.

Steam Generator and Turbine/Condenser Module

In addition to the above review steps, the review of each steam generator and turbine and condenser module will encompass the following technical areas:

1. remove fission products (except for NG) from the secondary side in the event of SG tube failures. The review will evaluate design features to collect MCES and TGSS exhausts for processing and monitoring, transfer and collection of spent resins for processing, packaging, and storage, and collect and route turbine building floor and equipment drains to the radwaste building or waste a handling facility located within the turbine building for all condenser/turbine modules. The review will consider necessary interfaces with liquid and gaseous waste management systems, decay heat removal system heat exchangers, feedwater condensate storage tanks, and radiation monitoring systems in avoiding uncontrolled and unmonitored releases to the environment and cross-contamination of non-radioactive systems. NRC requirements and NRC and industry guidance are provided in 10 CFR 20.1406, SRP Section 10.4.8, DSRS Sections 5.4.2.1, 5.4.2.2, 11.2, 11.3, 11.5, and 12.3-12.4, and Branch Technical Position (BTP) 5-1 (Monitoring of Secondary Side Water Chemistry in Pressurized Water Reactor (PWR) Steam Generators), Regulatory Guide 4.2, and NEI 08-08A.

2. The review of the design of each turbine and condenser module should determine whether the design features are based on existing NRC and industry guidance or rely on alternate methods in complying with the objectives of the TS on SG tube leakage rates (e.g., equivalent of TS 16.3.4.13). Current NRC and industry guidance is provided in SRP Section 10.4.8, DSRS Sections 5.4.2.1, 5.4.2.2, 11.2, 11.3, 11.5, and 12.3-12.4, and Branch Technical Position (BTP) 5-1 (Monitoring of Secondary Side Water Chemistry in Pressurized Water Reactor (PWR) Steam Generators), as they relate to detection sensitivities and

detector types specified for radiation monitors provided for compliance with NEI 97-06, underlying EPRI Guidelines, and guidance of RGs 1.29 and 1.45, and RIS 2009-02 (Revision 1) and IN 2005-24.

3. With respect to the TS on SG operational leakage detection instrumentation (e.g., equivalent of TS 16.3.4.15), the review should determine whether the SG tube leakage detection systems can reliably monitor the presence of fission products in secondary coolant in the event of SG tube failures. To the extent not covered in DSRS Sections 5.4.2.1, 5.4.2.2, 11.3, 11.5, 11.6, and 12.3-12.4, the review will address the placement of radiation detectors, types of detectors and detection sensitivities, selection of radionuclides forming the basis of instrumentation responses, assumed secondary coolant concentrations in deriving detection sensitivity thresholds in complying with technical specifications, and placement of radiation detectors in plant locations with low ambient external radiation levels to maximize instrumentation response times