U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER^{TM} iPWR DESIGN

9.4.2 SPENT FUEL POOL AREA VENTILATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of ventilation and air filtration

Secondary - None

I. AREAS OF REVIEW

The spent fuel pool area ventilation system (SFPAVS) is a subsystem of the Reactor Service Building (RSB) HVAC systems whose function is to maintain ventilation, permit personnel access, and control airborne radioactivity in the spent fuel pool equipment areas during normal operation and anticipated operational occurrences and following postulated fuel handling accidents. The SFPAVS is shared between the two units of a single mPower^{TM} module. .

The staff reviews the SFPAVS from the air intake to the point of discharge where the system connects to the gaseous cleanup and treatment system or the station vents to ensure compliance with the requirements of Title 10 of *Code of Federal Regulations* (10 CFR) Part 50, Appendix A, General Design Criteria (GDCs) 2, 4, 5, 60, and 61, and with 10 CFR 20.1406 and 10 CFR 50.63. The review includes such components as air intakes, ducts, air conditioning units, filters, blowers, isolation dampers, exhaust fans, and associated instrumentation and control systems used to govern operation of the system during normal and accident conditions. The review of the SFPAVS covers all areas containing or adjacent to the spent fuel pool, including the spent fuel pool cooling pump room, heat exchanger room, and pool coolant cleanup cells.

The mPower^{TM} SFPAVS may include the following classifications of equipment:

1. Safety-related and risk-significant equipment

2. Safety-related and nonrisk-significant equipment

3. Nonsafety-related and risk-significant Regulatory Treatment of Nonsafety Systems (RTNSS) equipment

4. Nonsafety-related nonrisk-significant equipment.

The mPower^{TM} application will include the classification of systems, structures, and components (SSCs), a list of risk significant SSCs, and a list of RTNSS equipment. Based on this information, the staff will review according to DSRS Section 3.2, NUREG-0800, Standard Review Plan (SRP) Sections 17.4 and 19.3 to confirm the determination of safety-related and risk-significant SSCs.

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The specific areas of review are as follows:

1. The staff reviews the SFPAVS to determine the safety significance of the system. Based on this determination, safety-related portions of the system are reviewed with respect to functional performance requirements during normal operation, adverse environmental occurrences, and subsequent to postulated accidents, including prolonged loss of offsite power that affects multiple modules onsite. The staff reviews safety-related portions of the system to ensure that:

   A. A single, active failure cannot result in loss of the system functional performance capability.

   B. Failures of nonseismic Category I equipment or components will not affect the SFPAVS.

2. Safety-related SFPAVS portions are also reviewed for the following:

   A. The capability to direct ventilation air from areas of low radioactivity to areas of potentially higher radioactivity.

   B. The capability to detect the need for isolation and to isolate portions of the system in the event of failures or malfunctions

   C. The capability to actuate components not normally operating that are required to operate during accident conditions and to provide necessary isolation.

   D. The expected environmental conditions in areas served by the SFPAVS and the extent, if any, to which the SFPAVS is relied upon to function for a prolonged Station Blackout (SBO) event.

3. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this Design Specific Review Standard (DSRS) section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this DSRS section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.

4. 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.

Review Interfaces

Other SRP and DSRS sections interface with this section as follows:

1. SRP Section 2.2.1-2.2.2: review to evaluate potential plant site external hazards or hazardous materials.

2. SRP Section 2.2.3: review to consider an applicant's probability analysis of potential accidents involving hazardous materials or activities at the plant site.

3. DSRS Sections 3.2.1 and 3.2.2: determination of the acceptability of the seismic and quality group classifications for system components.

4. DSRS Sections 3.3.1, 3.3.2, 3.5.1.4, 3.5.1.5, 3.5.3, 3.7.2, and SRP Sections 3.7.1, 3.7.3, 3.7.4, 3.8.4, and 3.8.5: determination of 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 (SSE), the probable maximum flood (PMF), tornado missiles and missiles generated onsite.

5. DSRS Section 3.9.1and SRP Section 3.9.2 and 3.9.3: determination that components, piping, and structures are designed in accordance with applicable codes and standards.

6. DSRS Section 3.9.6: review of the adequacy of the inservice testing program of pumps and valves.

7. DSRS Section 3.10: review of the seismic qualification of Category I instrumentation and electrical equipment.

8. DSRS Section 3.11: review of the environmental qualification of mechanical and electrical equipment.

9. DSRS Section 6.6: verification that inservice inspection requirements are met for system components.

10. DSRS Chapter 7and DSRS Section 8.3.1: determination of the adequacy of the design, installation, inspection, and testing of all essential electrical components (sensing, control and power) required for proper operation.

11. DSRS Section 11.3: review and evaluation ventilation and exhaust systems to detect and control leakage of radioactive contamination.

12. DSRS Section 11.5: review and evaluation of the capability of the SFPAVS to detect and control leakage of radioactive contamination from the system.

13. DSRS Section 12.3-12.4: evaluation of radiation protection criteria.

14. DSRS Section 16.0: review of proposed technical specifications.

15. SRP Chapter 17: review of reliability assurance and quality assurance programs.

16. SRP Chapter 19: review of SSCs for risk significance.

II. ACCEPTANCE CRITERIA

Requirements

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

1. GDC 2, “Design Bases for Protection Against Natural Phenomena,” as related to the system being capable of withstanding the effects of earthquakes.

2. GDC 4, “Environmental and Dynamic Effects Design Bases,” as it relates to the SFPAVS being appropriately protected against dynamic effects and being designed to accommodate the effects of, and to be compatible with, the environmental conditions of normal operation, maintenance, testing, and postulated accidents, including hazards from collocated site facilities. The GDC 4 evaluation includes the adequacy of environmental support for safety-related SSCs within areas served by the SFPAVS.

3. GDC 5, “Sharing of Structures, Systems, and Components,” as related to shared systems and components important to safety.

4. GDC 60, “Control of Release of Radioactive Materials to the Environment,” as related to the system’s capability to control suitably the release of radioactive materials in gaseous effluents to the environment.

5. GDC 61, “Fuel Storage and Handling and Radioactivity Control,” as related to the system’s capability to provide appropriate containment, confinement, and filtering to limit releases of airborne radioactivity to the environment from the fuel storage facility under normal and postulated accident conditions.

6. 10 CFR 20.1406, as related to the design and operational procedures to minimize contamination, minimize the generation of radioactive waste, and facilitate eventual decommissioning.

7. 10 CFR 50.63, as it relates to necessary support systems providing sufficient capacity and capability to ensure the capability for cope with an SBO event, including a prolonged SBO affecting multiple units. An analysis to determine capability for withstanding (if an acceptable alternate ac source is provided) or coping with an SBO event is required. The analysis should address, as appropriate, the potential failures of equipment/systems during the event (e.g., loss or degraded operability of heating, ventilating, and air conditioning systems, including the SFPAVS, as appropriate), the expected environmental conditions associated with the event, the operability and reliability of equipment necessary to cope with the event under the expected environmental conditions, and the habitability of plant areas requiring operator access during the event and associated recovery period.

8. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility

that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the Atomic Energy Act (AEA), and the U.S. Nuclear Regulatory Commission's (NRC's) regulations.

9. 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 combined license, 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. Identifying the differences between this DSRS section and the design features, analytical techniques, and procedural measures proposed for the facility, and discussing how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria, is sufficient to meet the intent of 10 CFR 52.47(a)(9), "Contents of applications; technical information." The same approach may be used to meet the requirements of 10 CFR 52.79(a)(41) for COL applications.

The design of safety-related SFPAVS portions is acceptable if the integrated design of the system is in accordance with the following criteria:

1. For GDC 2, acceptance is based on the guidance of RG 1.29, Position C.1 for safety-related portions and Position C.2 for nonsafety-related portions.

2. For GDC 4, acceptance is based on satisfying the acceptance criteria for environmental and dynamic effects in the following DSRS sections, as they apply to the SFPAVS: SRP and DSRS Sections 3.5.1.1, 3.5.1.4, 3.5.1.5, 3.5.2, and 3.6.1.

3. For GDC 5, acceptance is based on the determination that the use of the SFPAVS in multiple-unit plants during an accident in one unit does not significantly affect the capability to conduct a safe and orderly shutdown and cool-down in the remaining unit(s).

4. For GDC 60, acceptance is based on the guidance of RGs 1.52 and 1.140 as related to design, inspection, testing, and maintenance criteria for post-accident and normal atmosphere cleanup systems, ventilation exhaust systems, air filtration, and adsorption units of light-water-cooled nuclear power plants. For RG 1.52 Revision 2, the applicable regulatory position is C.2. For RG 1.52 Revision 3, the applicable regulatory position is C.3. For RG 1.140 Revision 1, the applicable regulatory positions are C.1 and C.2. For RG 1.140 Revision 2, the applicable regulatory positions are C.2 and C.3.

5. For GDC 61, acceptance is based on the guidance of RG 1.13 as to the design of the ventilation system for the spent fuel storage facility, Position C.4.

6. 10 CFR 20.1406. Minimization of contamination to the facility and the environment, and designs to facilitate eventual decommissioning, will be considered acceptable if the design identifies provisions to detect contamination that may enter as inleakage from other systems, identifies potential collection points such as water treatment systems or system low points, and addresses the long term control of radioactive material in the system. DC/COL-ISG-06 and RG 4.21 relate to acceptable levels of detail and content required to demonstrate compliance with 10 CFR 20.1406. NEI 08-08A, Revision 0, "Generic FSAR Template Guidance for Life Cycle Minimization of Contamination," also provides NRC-endorsed industry guidance on life-cycle minimization of contamination.

7. Loss of All Alternating Current Power. Information that addresses the requirements of 10 CFR 50.63 regarding the necessary support systems providing sufficient capacity and capability for coping with an SBO event, including a prolonged SBO affecting multiple units, will be considered acceptable if the guidance of RG 1.155, including position C.3.2.4 is applied appropriately.

8. 10 CFR 52.47(b)(1) specifies that the application of a design certification should contain proposed ITAAC for SSCs necessary and sufficient to assure the plant is built and will operate in accordance with the design certification. 10 CFR 52.97(b) specifies that the COL identifies the ITAAC for SSCs necessary and sufficient to assure that the facility has been constructed and will be operated in conformity with the license. SRP Section 14.3 provides guidance for reviewing the ITAAC. The requirements of 10 CFR 52.47(b)(1) and 10 CFR 52.97(b) will be met, in part, by identifying inspections, tests, analyses, and acceptance criteria of the top-level design features of the SFPAVS in the design certification application and the combined license, respectively.

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. GDC 2, as related to the system being capable of withstanding the effects of earthquakes, requires that SSCs important to safety be designed to withstand the effects of a design-basis earthquake without loss of capability to perform their safety functions.

   The function of the SFPAVS is to provide ventilation, to permit personnel access, and to control the concentration of airborne radioactive material in the spent fuel pool equipment areas during normal operation and anticipated operational occurrences and after postulated fuel handling accidents. The requirement specified in GDC 2 ensures that, during and after a design basis earthquake, the SFPAVS will remain functional so that any fuel damage will not result in potential offsite doses in excess of 5 mSv (0.5 rem) to the whole body or an equivalent dose to any part of the body.

   Meeting the GDC 2 requirement provides assurance that the SFPAVS will not fail to operate as designed, thus protecting against the uncontrolled release of airborne radioactive materials in the event of a design-basis earthquake.

2. GDC 4 requires that SSCs important to safety be designed to accommodate the effects of, and to be compatible with, environmental conditions of normal operation, maintenance, testing, and postulated accidents, GDC 4 also requires that SSCs important to safety be appropriately protected against dynamic effects (including those of

missiles, pipe whipping, and discharging fluids) that could result from equipment failures or from events and conditions outside the nuclear power unit. RGs 1.115 and 1.117 provide guidance associated with protection against turbine missiles and tornado design classification.

The function of the SFPAVS is to provide a suitable and controlled environment for the spent fuel pool area during normal operation, anticipated operational occurrences, and during and after postulated accidents, including loss of offsite power. To ensure performance of these functions under accident conditions, portions of the SFPAVS must be designed to accommodate accident environmental effects and be appropriately protected from dynamic effects associated with postulated accidents. The requirements of GDC 4 ensure that spent fuel pool area safety-related systems and components (with environmental support from the SFPAVS) and safety-related portions of the SFPAVS are designed to address the expected environmental conditions and dynamic effects associated with the specified events and conditions for which they are required to function, including hazards associated with collocated site facilities.

GDC 4 requirements provide assurance that the SFPAVS will support the functioning of safety-related systems and components by maintaining suitable environmental conditions for performance of safety functions.

3. GDC 5 requires that SSCs important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.

   For the SFPAVS, application of GDC 5 means that its component parts need to be essentially independent in order to ensure that an accident in one unit of a multiple-unit facility will not propagate to other units. Therefore the SFPAVS needs to be designed to accommodate loss of services from any one unit without affecting operation of the overall system.

   Meeting the GDC 5 requirements provide assurance that a failure or accident in one unit will not affect additional units of a multiple-unit site.

4. GDC 60 requires provisions to be included in the nuclear power unit design to ensure suitable controls on the release of radioactive materials in gaseous effluents during normal reactor operation, including anticipated operational occurrences.

   During transfer or movement of spent fuel in the fuel storage pool, damage to the fuel cladding could result in potential releases of radioactive gases and aerosols to the atmosphere; thus, GDC 60 is applicable to spent fuel storage areas. Atmosphere cleanup systems are included in the SFPAVS design to reduce the quantities of radioactive materials in gaseous effluents released to the environment. RGs 1.140 and 1.52 offer design, testing, and maintenance criteria acceptable to the staff for air filtration and adsorption units of normal ventilation exhaust systems and for engineered safety feature atmosphere cleanup systems in light-water-cooled nuclear power plants.

   Meeting the GDC 60 requirements provides assurance that the release of radioactive materials entrained in gaseous effluents will not exceed the limits specified in 10 CFR Part 20 for normal operation and anticipated operational occurrences.

10 CFR 20.1406 requires the design of a nuclear power unit to address minimization of contamination of the facility and the environment, and to facilitate eventual decommissioning. 10 CFR 20.1406 applies to this DSRS section because the SFPAVS could interface with contaminated structures or systems. DC/COL-ISG-06 and RG 4.21 provide guidance to meet 10 CFR 20.1406. Specific guidance to meet 10 CFR 20.1406 is identified in RG 4.21 Positions C.1 through C.4. NEI 08-08A also provides NRC-endorsed industry guidance on life-cycle minimization of contamination.

5. GDC 61 requires that the fuel storage and handling, radioactive waste, and other systems that may contain radioactive materials be designed to ensure adequate safety under normal and postulated accident conditions. This criterion specifies that such facilities be designed to include appropriate containment, confinement, and filtering systems.

   Because it is necessary to move spent fuel within the spent fuel pool and because damage to the fuel cladding could result in potential releases of radioactive gases and aerosols to the atmosphere, the SFPAVS design must include provisions for isolating the normal ventilation system and actuating the emergency filtration and adsorption system before radioactive airborne particles and gases reach the ventilation exhaust ducts. Guidance on the acceptable design of such systems is provided by RG 1.13, Position C.4, and RG 1.25 (referenced in Position C.4).

   Meeting the GDC 61 requirements provides assurance that releases of radioactive materials during normal operation, anticipated operational occurrences, and postulated accidents will not result in radiation doses in excess of the limits specified in 10 CFR Part 20.

6. 10 CFR 50.63 requires a demonstration of the capability of a nuclear power plant to withstand and recover from a SBO (i.e., loss of offsite electric power system concurrent with reactor trip and unavailability of the onsite emergency alternating current (AC) electric power system), including a prolonged SBO affecting multiple reactor modules. A SBO analysis covering a minimum acceptable duration (either to withstand the event until an alternate AC source and shutdown systems are lined up for operation or to cope with it for its duration, including the recovery period) is required. RG 1.155 provides guidance for compliance with SBO requirements.

   Regardless of the extent, if any, to which the SFPAVS is expected to function to maintain suitable environmental conditions during a SBO event, spent fuel pool heating, ventilation, and cooling (HVAC) equipment necessary for withstanding or coping with the event, should be able to function under the expected environmental conditions of the event. The reviewer therefore verifies that the SBO analysis appropriately addresses the potential failures of equipment/systems during the event (e.g., loss or degraded operability of the SFPAVS, as appropriate), the expected environmental conditions of the event, the operability and reliability of equipment necessary to cope with the event under the expected environmental conditions, and the habitability of plant areas requiring operator access during the event and recovery period.

   Those portions of the SFPAVS, if any, that are identified in a coping analysis as necessary to support the functioning of equipment required to cope with the event or recovery therefrom are verified to be of sufficient capacity and capability for such support.

10 CFR 50.63 requirements provide assurance that necessary operator actions can be performed and that necessary spent fuel pool HVAC equipment will be functional under the expected environmental conditions during and following an SBO, thereby ensuring that spent fuel pool accidents are acceptably managed.

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 procedures are used during the standard DC review to determine that the design criteria and bases and the preliminary design, as set forth in the SAR, meet the acceptance criteria of Subsection II of this DSRS section.

These procedures should be followed for the review of a DC and a COL application.

The procedures COL reviews include a determination that the proposed technical specifications prepared are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

1. Programmatic Requirements - In accordance with the guidance in NUREG-0800 "Introduction," Part 2 as applied to this DSRS Section, the staff will review the programs proposed by the applicant to satisfy the following programmatic requirements. If any of the proposed programs satisfies the acceptance criteria described in Subsection II, it can be used to augment or replace some of the review procedures. It should be noted that the wording of "to augment or replace" applies to nonsafety-related risk-significant SSCs, but "to replace" applies to nonsafety-related nonrisk-significant SSCs according to the "graded approach" discussion in NUREG-0800 "Introduction," Part 2. Commission regulations and policy mandate programs applicable to SSCs that include:

    - Maintenance Rule, SRP Section 17.6 (DSRS Section 13.4, Table 13.4, Item 17, RG 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants." and RG 1.182; "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants".

    - Quality Assurance Program SRP Sections 17.3 and 17.5 (DSRS Section 13.4, Table 13.4, Item 16).

    - Technical Specifications (DSRS Section 16.0 and SRP Section 16.1) – including brackets value for DC and COL. Brackets are used to identify information or characteristics that are plant specific or are based on preliminary design information.

    - Reliability Assurance Program (SRP Section 17.4).

    - Initial Plant Test Program (RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants, "DSRS Section 14.2, and DSRS Section 13.4, Table 13.4, Item 19).

- ITAAC (DSRS Chapter 14).

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

3. The FSAR is reviewed to verify that the system description section and schematics or piping and instrumentation diagrams (P&IDs), if applicable, show the SFPAVS equipment used for normal operation and the ambient temperature limits for the area serviced, including flow rates and flow paths in various zones, appropriate pressurization of clean areas, makeup air supply, and filtration capability. The system performance requirements section is reviewed to determine that it describes allowable component operational degradation (e.g., loss of cooling function, damper leakage) and procedures that will be followed to detect and correct these conditions. The reviewer, using results from failure modes and effects analyses as appropriate, determines that the safety-related portion of the system is capable of functioning in spite of the loss of any active component. Typically, required redundancy is provided by separate, independent subsystems for safety-related functions.

   The system review also should demonstrate compliance with applicable industry standard: American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) AG-1-2009, “Code on Nuclear Air and Gas Treatment,” ASHRAE 62.1-2010, “Ventilation for Acceptable Indoor Air Quality,” ASME N509-2002, “Nuclear Power Plant Air-Cleaning Units and Components,” and ASME N510-2007, “Testing of Nuclear Air Treatment Systems.”

4. The system component descriptions, characteristics, and schematics or P&IDs, if applicable are then reviewed to determine that:

   A. Essential portions of the SFPAVS are correctly identified and are isolable from nonessential portions of the system. The schematics or P&IDs, if applicable are reviewed to verify that they clearly indicate physical divisions between such portions and design classification changes. System drawings are also reviewed to verify that they show the means for accomplishing isolation, and the system description is reviewed to identify minimum performance requirements for the isolation dampers, including criteria for manual or automatic actuation of system components or dampers.

      For the typical system, the drawings and description are reviewed to verify that two automatically-operated isolation dampers in series separate nonessential from essential portions and components.

B. Essential portions of the SFPAVS, including the isolation dampers separating essential from nonessential portions, are classified seismic Category I. Component and system descriptions in the final safety analysis report (FSAR) that identify mechanical and performance characteristics are reviewed to verify that the above classifications have been included, and that the schematics or P&IDs, if applicable indicate any points of change in design classification.

C. Design provisions have been made that permit appropriate inservice inspection and functional testing of system components important to safety. Compliance with the industry standard American Society for testing and Materials (ASTM) D3803-89, "Standard Test Methods for Radiological Testing of Nuclear-Grade Gas-Phase Adsorbers," should be demonstrated. The design is acceptable if the FSAR information delineates a testing and inspection program and if the system schematics or P&IDs, if applicable show the necessary test recirculation loops around fans or isolation dampers that would be required by this program.

5. The SFPAVS is reviewed to ensure that it meets the requirements of 10 CFR 20.1406 for which guidance is provided in DC/COL-ISG-06, RG 4.21, and NEI 08-08A. The review includes provision to monitor, collect, and control contaminated liquids and gaseous effluents (e.g., condensate from coolers or in ductwork) that may form or be carried through the system. The provisions should include the underground HVAC ducts and piping, if any. The reviewer verifies that the system has been designed so that system function will be maintained as required in the event of adverse environmental phenomena or prolonged loss of offsite power that affects multiple modules onsite. The reviewer evaluates the system, using engineering judgment and failure modes and effects analyses, to determine that:

   A. The failure of nonessential portions of the systems or of other systems not designed to seismic Category I standards and located close to essential portions of the system or of nonseismic Category I structures that house, support, or are close to essential portions of the SFPAVS, will not preclude operation of the essential portions of the SFPAVS. Reference to FSAR sections describing site features and schematics or P&IDs, if applicable of the general site arrangement and the FSAR tabulation of seismic design classifications for structures and systems will be necessary. Statements in the FSAR that verify that the above conditions are met are acceptable.

   B. The essential portions of the SFPAVS are protected from the effects of floods, hurricanes, tornadoes, and internally and externally generated missiles. Flood and missile protection criteria are discussed and evaluated in detail in DSRS Chapter 3. The location and the design of the system, structures, and fan rooms (cubicles) are reviewed to determine that the degree of protection is adequate. A statement to the effect that the system is located in a tornado-, missile-, and flood-protected seismic Category I structure or that components of the system will be located in individual cubicles or rooms that will withstand the effects of both flooding and missiles, is acceptable.

C. The total system has the capability to detect and control leakage of radioactive contamination from the system. The design is acceptable if it meets the following conditions:

i. The schematics or P&IDs, if applicable show capability to isolate nonessential SFPAVS portions by two automatically-actuated dampers in series.

ii. The SFPAVS has provisions to filter radioactive contaminants from the spent fuel area by automatically isolating the normal ventilation system and actuating the emergency exhaust system before the first contaminated airborne particles and gases reach the normal ventilation exhaust ducts.

D. Components and subsystems necessary for preventing the release of radioactive contaminants can function as required in the event of prolonged loss of offsite power affecting multiple units of a multi-module site and can securely close the isolation dampers providing an isolated confinement during a SBO and be returned to service following a SBO once either off-site or on-site ac electrical power is restored. The system design will be acceptable if the SFPAVS meets minimum system requirements as stated in the SAR, assuming a failure of a single active component, within the system itself or in the auxiliary electric power source which supplies the system. The FSAR is reviewed to determine that for each SFPAVS component or subsystem affected by the loss of offsite power, the resulting system flow capacity will not cause the loss of preferred direction of air flow from areas of low potential radioactivity to areas of higher potential radioactivity. Statements in the FSAR and the results of failure modes and effects analyses are considered in verifying that the system meets these requirements. This will be an acceptable verification of system functional reliability.

6. The descriptive information, SFPAVS schematics or P&IDs, if applicable, and failure modes and effects analyses in the FSAR are reviewed to ensure that essential portions of the system can function following design basis accidents assuming a concurrent single active failure. The reviewer evaluates the analyses presented in the FSAR to ensure function of required components, traces the availability of these components on system schematics or P&IDs, if applicable, and checks that the FSAR contains verification that minimum system isolation or filtration requirements are met for each accident situation for the required time spans. For each case, the design will be acceptable if minimum system requirements are met.

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

For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

8. 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 staff's technical review and analysis, as augmented by the application of programmatic requirements in accordance with the staff's technical review approach in the DSRS Introduction, support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The SFPAVS includes all components and ductwork from air intake to the point of discharge where the system connects to the gaseous cleanup and treatment system or station vents. All portions of the system whose failure may result in release of radioactivity which causes an offsite dose of more than 5 mSv (0.5 rem) to the whole body or an equivalent dose to any part of the body shall be classified seismic Category I and safety related. Based on the review of the applicant's proposed design criteria, the design bases, and safety classification for the SFPAVS and the requirements for system performance to prevent an unacceptable release of contaminants to the environment during normal, abnormal, and accident conditions, the staff concludes that the design of the spent fuel pool area ventilation system and supporting systems is acceptable and meets NRC regulations as set forth in GDCs 2, 4, 5, 60, and 61 and 10 CFR 20.1406 and 10 CFR 50.63. This conclusion is based on the following findings:

1. The applicant has met the requirements of GDC 2 with respect to the system being capable of withstanding the effects of earthquakes by meeting the guidelines of RG 1.29, "Seismic Design Classification," Position C.1 for safety-related portions of the system and Position C.2 for nonsafety-related portions of the system.

2. The applicant has met the requirements of GDC 4 with respect to the system being capable of withstanding the effects of environmental conditions and dynamic effects to maintain spent fuel pool area environmental conditions.

3. The applicant has met the requirements of GDC 5 with respect to the capability of shared systems and components important to safety to perform required safety functions since a single failure of any shared portion of the system will not affect the system's safety function for either unit.

4. The applicant has met the requirements of GDC 60 and 20.1406 with respect to the capability of the system to suitably control release of gaseous radioactive effluents to the environment by meeting the guidelines of RGs 1.52 and 1.140 as related to design, inspection, testing, and maintenance criteria for post-accident and normal atmosphere cleanup systems, ventilation exhaust systems, air filtration, and adsorption units of light-water-cooled nuclear power plants. For RG 1.52 Revision 2, the applicable regulatory position is C.2. For RG 1.52 Revision 3, the applicable regulatory position is C.3. For RG 1.140 Revision 1, the applicable regulatory positions are C.1 and C.2. For RG 1.140 Revision 2, the applicable regulatory positions are C.2 and C.3.

5. The applicant has met GDC 61 requirements with respect to the system's capability to provide appropriate containment, confinement, and filtering to limit releases of airborne radioactivity to the environment from the fuel storage facility under normal and postulated accident conditions by meeting the guidelines of RG 1.13, Position C.4.

6. The applicant has met the requirements of 10 CFR 50.63 by demonstrating that suitable environmental conditions to support operator access/egress and equipment functionality will be maintained during an SBO event, including a prolonged SBO affecting multiple reactor units or modules, and its associated recovery period affecting spent fuel pool HVAC equipment whose function is required to maintain the safe condition of the plant in the event of an SBO and by meeting the applicable guidance of RG 1.155, "Station Blackout."

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.

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 staff will use this DSRS section in performing safety evaluations of mPower™-specific design certification DC, or COL, applications submitted by applicants pursuant to 10 CFR Part 52. The staff will use the method described herein to evaluate conformance with Commission regulations.

Because of the numerous design differences between the mPower™ and large light-water nuclear reactor power plants, and in accordance with the direction given by the Commission in SRM- COMGBJ-10-0004/COMGEA-10-0001, "Use of Risk Insights to Enhance the Safety Focus of Small Modular Reactor Reviews," dated August 31, 2010 (ML102510405), to develop risk-informed licensing review plans for each of the small modular reactor reviews including the associated pre-application activities, the staff has developed the content of this DSRS section as an alternative method for mPower™ -specific DC, or COL submitted pursuant to 10 CFR Part 52 to comply with 10 CFR 52.47(a)(9), "Contents of applications; technical information."

This regulation states, in part, that the application must contain "an evaluation of the standard plant design against the SRP revision in effect 6 months before the docket date of the application." The content of this DSRS section has been accepted as an alternative method for complying with 10 CFR 52.47(a)(9) as long as the mPower™ DCD FSAR does not deviate significantly from the design assumptions made by the NRC staff while preparing this DSRS section. The application must identify and describe all differences between the standard plant design and this DSRS section, and discuss how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria. If the design assumptions in the DC application deviate significantly from the DSRS, the staff will use the SRP as specified in 10 CFR 52.47(a)(9). Alternatively, the staff may supplement the DSRS section by adding appropriate criteria in order to address new design assumptions. The same approach may be used to meet the requirements of 10 CFR 52.79(a)(41) for COL applications.

VI. REFERENCES

1. 10 CFR Part 20.1406, “Minimization of Contamination.”

2. 10 CFR 50.63, “Loss of All Alternating Current Power.”

3. 10 CFR Part 50, Appendix A, GDC 2, “Design Bases for Protection Against Natural Phenomena.”

4. 10 CFR Part 50, Appendix A, GDC 4, ”Environmental and Dynamic Effects Design Bases.”

5. 10 CFR Part 50, Appendix A, GDC 5, “Sharing of Structures, Systems, and Components.”

6. 10 CFR Part 50, Appendix A, GDC 60, “Control of Releases of Radioactive Materials to the Environment.”

7. 10 CFR Part 50, Appendix A, GDC 61, “Fuel Storage and Handling and Radioactivity Control.”

8. RG 1.13, “Fuel Storage Facility Design Basis.”

9. RG 1.25, “Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors (Safety Guide 25)”

10. RG 1.29, “Seismic Design Classification.”

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

12. RG 1.140, “Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants.”

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

14. RG 1.160, “Monitoring the Effectiveness of Maintenance at Nuclear Power Plants.”

15. RG 1.182, “Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants.”

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

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

18. RG 1.115, “Protection Against Low-Trajectory Turbine Missiles.

19. RG 1.117, “Tornado Design Classification.

20. RG 1.155, ”Station Blackout,” August 1988.

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

22. DC/COL-ISG-06, “Final Interim Staff Guidance Evaluation and Acceptance Criteria for 10 CFR 20.1406 to Support Design Certification and Combined License Applications”.

23. NEI 08-8A, Revision 0, “Generic FSAR Template Guidance for Life Cycle Minimization of Contamination.

24. ASME Code AG-1, “Code for Nuclear Air and Gas Treatment,” 2009.

25. ASHRAE Standard 62.1-2010, “Ventilation for Acceptable Air Quality.”

26. ASME N509-2002, “Nuclear Power Plant Air-Cleaning Units and Components.”

27. ASME N510-2007, “Testing of Nuclear Air Treatment Systems.”