U.S. NUCLEAR REGULATORY COMMISSION

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

## 9.4.3 REACTOR SERVICE BUILDING HVAC SYSTEMS

I. AREAS OF REVIEW

The reactor service building (RSB) heating, ventilation, and cooling (HVAC) systems provide required environmental conditions to RSB areas, including both radiological controlled areas (RCA) and non-radiological control areas during normal plant operations. The RCA and non-RCA HVAC subsystems are independent with no cross ties from any non-RCA subsystem to RCA subsystem. Radiological controlled areas HVAC systems are:

- Spent fuel pool area (see DSRS Section 9.4.2)
- Radioactive waste storage areas and rooms
- Decontamination area
- Hot machine shop
- Chemical calibration lab
- Nuclear sampling room

Non-radiological controlled areas HVAC systems are:

- Class 1E battery rooms and Class 1E switchgear rooms
- Alternate shutdown area
- Diesel generator rooms (see DCD Section 9.4.7)
- Security area
- Safe shutdown earthquake Fire Pump Room
- Main access area
- Control room area ventilation system (see DSRS Section 9.4.1)

The reviews of the RSB HVAC systems governed by this section are appropriate to the potential hazards associated with these systems. The diesel generator rooms' HVAC systems are necessary to support the operation of the standby diesel generators. The HVAC systems for the Class 1E battery rooms and Class 1E switchgear rooms provide cooling and ventilation functions for the batteries. The building structure provides a passive heat sink to limit heat-up for 72 hours following a loss of all plant alternating current (AC) power, and ventilation to remove possible hydrogen gas generation is required only during times of battery charging.

Except for the control room area ventilation system and the spent fuel pool area ventilation system which are described in other DSRS sections, the RSB HVAC systems are designed to maintain ventilation, temperature, and humidity levels hospitable for human activities and equipment operability; permit personnel access; and control the concentration of airborne radioactive material in RSB rooms and areas; and to support operation of the standby diesel generators during normal operations and accident conditions. Isolation or emergency filtration functions may occur upon loss of AC power. The RSB houses shared systems, including

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ventilation systems, used to support operations of each unit of a two-unit mPower™ reactor module.

The staff reviews the RSB HVAC systems from their air intakes to the points of discharge where the systems connect to the gaseous cleanup and treatment system or station vents to ensure compliance with the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix A, General Design Criteria (GDCs) 2, 4, 5, 17, and 60 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 systems under normal and accident conditions. The review of the RSB HVAC systems covers the radioactive waste and controlled-access nonradioactive areas and their relationships to safety-related areas in the RSB.

The mPower™ RSB HVAC systems 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™ 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.

The specific areas of review are as follows:

1. The functional performance requirements and the air treatment equipment for the RSB HVAC systems are reviewed to determine whether the ventilation systems or portions of the systems have been designed or need to be designed as safety-related systems. Based on this determination, the safety-related portions of the systems are reviewed with respect to functional performance requirements during normal operation, adverse environmental occurrences, and during and subsequent to postulated accidents, including the prolonged loss of offsite power affecting multiple units of a multi-module site. Safety-related portions of the systems are reviewed 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 RSB HVAC systems.

2. The staff also reviews safety-related portions of the RSB HVAC systems with respect to the following:

A. The capability to direct ventilation air from areas of low radioactivity to areas of progressively 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 and the capability of the system to function under such conditions.

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

D. The ability of the heating and cooling systems to maintain a suitable ambient temperature range in the areas serviced and to ensure proper performance of equipment contained in these areas.

E. The capability of the system to circulate sufficient air to prevent accumulation of flammable or explosive gas or fuel-vapor mixtures from components such as storage batteries and stored fuel.

F. The expected environmental conditions in areas served by the RSB HVAC systems and the extent, if any, to which the RSB HVAC systems are 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 SSCs related to this DSRS section in accordance with SRP Section 14.3, "nspections, 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 design-specfic review standard (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: review to determine 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: review to determine the acceptability of the design analyses, procedures, and criteria to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena like the safe shutdown earthquake, the probable maximum flood, and tornado missiles.

5. DSRS Section 3.9.1 and SRP Sections 3.9.2 and 3.9.3: review to determine that the 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 6.6: verification whether inservice inspection requirements are met for system components.

9. DSRS Chapter 7 and DSRS Sections 8.3.1 and 8.3.2: review to determine the adequacy of the design, installation, inspection, and testing of all essential electrical components (sensing, control and power) required for proper operation.

10. SRP Section 9.5.1: fire protection.

11. DSRS Section 9.5.8: standby diesel engine combustion air intake and exhaust system.

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

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 RSB HVAC systems 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 RSB HVAC systems.

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

4. GDC 17, “Electric Power Systems,” as related to support of the operability of the onside Direct Current (DC) power system and onsite AC power system provided to permit functioning of structures, systems, and components important to safety.

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

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 a 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 RSB HVAC systems, 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 RSB HVAC systems safety-related 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, information that addresses the requirements of GDC 4 regarding consideration of environmental and dynamic effects will be considered acceptable if the acceptance criteria in the following SRP and DSRS sections, as they apply to the RSB HVAC systems are met: 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 RSB HVAC systems 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 17, acceptance is based on the determination that the RSB HVAC systems support operation of the DC power system and onsite AC power system meet the acceptance criteria of DSRS Sections 8.3.1 and 8.3.2.

5. 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.

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 in-leakage 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 a 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 RSB HVAC systems 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 RSB HVAC systemis to maintain ventilation, to permit personnel access, and to control airborne radioactivity in the RSB areas during normal operation and anticipated operational occurrences and during and after postulated accidents, including loss of offsite power. This requirement ensures that in the event of a design-basis earthquake, essential portions of the RSB HVAC systems will remain functional and the failure of any nonessential portion of the system or of other systems not designed to seismic Category I standards will not result in 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 requirements provides assurance that the RSB HVAC systems will operate as designed, thus protecting against release of radioactivity in excess of regulatory limits.

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 RSB HVAC systems is to provide a suitable and controlled environment for the RSB rooms and areas 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 RSB HVAC systems 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 RSB rooms and areas with safety-related systems and components (with environmental support from the RSB HVAC systems) and safety-related portions of the RSB HVAC systems 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 RSB HVAC systems 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 RSB HVAC systems, GDC 5 requires that the component parts be essentially independent to ensure that an accident in one unit of a multiple-unit facility will not propagate to other units. Therefore, the RSB HVAC systems for each unit should be designed to accommodate the load resulting from accident conditions. At the same time, the operating environment of equipment associated with unaffected units must be maintained within specified limits.

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

4. GDC 17 requires that onsite electric power systems be provided to permit functioning of SSCs that are important to safety. The safety-related DC power system provides power for safety-related protection, actuation, and monitoring I&C and other equipment and to support human habitability and performance requirements. The standby diesel generators provide power to the systems that serve as backups to safety-related passive emergency core cooling systems. RSB HVAC systems provide assurance that the environmental conditions necessary for the operability of safety-related SSCs are met, including air quality, flow rates, temperature, humidity, filtration, pressurization, flow paths, ventilation of hazardous gasses, etc.

5. 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.

   GDC 60 requirements apply to the design of the RSB HVAC systems because their functions are to control the quantities of radioactive materials in gaseous effluents released to the environment from normal ventilation systems. RGs 1.140 and 1.52 provide 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 atmospheric cleanup systems in light-water-cooled nuclear power plants.

   Meeting the GDC 60 requirements provides assurance that 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 RSB HVAC systems 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.

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 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 RSB HVAC systems are expected to function to maintain suitable environmental conditions during an SBO event, a RSB HVAC system's 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 RSB HVAC systems, 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 RSB HVAC systems, 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 RSB HVAC equipment will be functional under the expected environmental conditions during and following an SBO, thereby ensuring that accidents consequences are acceptably managed.

## III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

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 of this document:

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 preliminary safety analysis report (SAR), meet the acceptance criteria of Subsection II of this DSRS section.

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

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

The primary reviewer coordinates this review with areas of responsibility assigned to other reviewers as stated in subsection I of this DSRS section. The primary reviewer uses such inputs as required to ensure that this review procedure is complete.

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, schematics or P&IDs, if applicable, and drawings show the RSB HVAC systems equipment used for normal operations, and the ambient temperature and humidity limits for the areas serviced, including air flow rates and paths in various zones, appropriate pressurization of the RCA zones, and makeup air and filtration requirements. The system performance requirements are reviewed to determine that it describes allowable component operational degradation (e.g., loss of function, damper leakage) and describes the procedures that will be followed to detect and correct these conditions. The reviewer, using results from failure modes and effects analyses or other appropriate analyses, determines that the safety-related portion of the system is capable of functioning in spite of the failure 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 standards: American National Standards Institute/American Nuclear Society (ANSI/ANS) 59.2-1985, "Safety Criteria for Nuclear Power Plant HVAC Systems Located Outside Primary Containment," American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) 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 schematics or P&IDs, if applicable, layout drawings, and component descriptions and characteristics then are reviewed to determine that:

   A. Essential portions of the RSB HVAC systems are correctly identified and are isolable from nonessential portions of the system. The schematics or P&IDs, if applicable, and drawings are reviewed to verify that they clearly indicate the physical divisions between such portions and indicate design classification changes. System drawings are also reviewed to verify that they show the means for accomplishing automatic or manual isolation for all operational modes in response to radiation or other actuation signals. 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 portions and components from the essential portions.

   B. Essential portions of the RSB HVAC systems, 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 seismic classification has been included, and that the system schematics or P&IDs, if applicable, and drawings indicate any points of change in design classification.

C. Design provisions have been made that permit appropriate in-service inspection and functional testing of system components important to safety. Compliance with the industry standard American Society for Testing and Materials (ASTM) D3803-91, "Standard Test Method for Nuclear-Grade Activated Carbon", should be demonstrated. The design is acceptable if the FSAR information delineates a testing and inspection program and if the system drawings show the necessary test recirculation loops around fans or isolation dampers that would be required by this program.

5. The RSB HVAC systems are reviewed to ensure that they meet 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 (e.g., condensate from coolers or in ductwork) that may form or be carried through the system.

6. The reviewer verifies that essential portions of the system have been designed so that system function will be maintained as required in the event of an earthquake, flood, hurricance, tornado, internally- and externally-generated missiles, or loss of offsite power. The reviewer evaluates the system, using engineering judgment and the results of failure modes and effects analyses to determine that:

   A. The failure of nonessential portions of the system 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 RSB HVAC systems, will not preclude their operation. Reference to FSAR sections describing site features and the general arrangement, to layout drawings, and to 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. Components and subsystems necessary for preventing the release of radioactive contaminants can function as required in the event of a loss of offsite power. The system design is acceptable if the RSB HVAC systems meet 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 RSB HVAC systems 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.

7. The descriptive information, schematics or P&IDs, if applicable, systems drawings, and failure modes and effects analyses (or other appropriate 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 functioning of required components, traces the availability of these components on system drawings, and checks that the FSAR contains verification that minimum system isolation or filtration

requirements are met for each accident situation for required time spans. For each case the design is acceptable if it meets minimum system requirements.

8. For review of a DC application, the reviewer should follow the above numbered procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site-specific conditions and parameters), set forth in the 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 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 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 RSB HVAC systems include all components and ductwork from air intake to the point of discharge where the systems connect to the gaseous cleanup and treatment systems 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, design bases, and safety classification for the RSB HVAC systems and the requirements for system performance to preclude an unacceptable release of contaminants to the environment during normal, abnormal, and accident conditions, the staff concludes that the design of the RSB HVAC systems and supporting systems is in conformance with NRC regulations as set forth in GDC 2, "Design Bases for Protection Against Natural Phenomena," GDC 4, "Environmental and Dynamic Effects Design Bases," GDC 5, "Sharing of Structures, Systems, and Components," GDC 60, "Control of Releases of Radioactive Materials to the Environment," 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, "Design Bases for Protection Against Natural Phenomena," with respect to the system being capable of withstanding the effects of earthquake 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 GCD 4, "Environmental and Dynamic Effects Design Bases," 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, "Sharing of Structures, Systems, and Components Important to Safety to Perform Required Safety Function," with respect to capability of shared systems and components important to safety to perform required safety functions.

4. The applicant has met the requirements of GDC 17, Electric Power Systems, with respect to the capability of the these systems to perform required safety functions.

5. The applicant has met the requirements of General Design Criterion 60, "Control of Releases of Radioactive Materials to the Environment," and 10 CFR 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.

   The staff concludes that the RSB HVAC systems design complies with all applicable GDCs and positions of the RGs cited and is, therefore, acceptable.

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 RSB HVAC systems 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$^{TM}$-specific 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$^{TM}$ 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 17, "Electric Power Systems."

7. 10 CFR Part 50, Appendix A, GDC 60, "Control of Releases of Radioactive Materials to the Environment."

8. RG 1.29, "Seismic Design Classification."

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

10. RG 1.52, "Design, Testing, and Maintenance Criteria for Post-Accident Engineered-Safety-Feature Atmospheric Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."

11. RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants."

12. RG 1.155, "Station Blackout," August 1988.

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

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

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

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

17. 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”.

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

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

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

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

22. ANSI/ANS 59.2-1985, “Safety Criteria for Nuclear Power Plant HVAC Systems Located Outside Primary Containment.” [discontinued]

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

24. ASTM D3803-91, ”Standard Test Method for Nuclear-Grade Activated Carbon,” Reapproved 2009.