



U.S. NUCLEAR REGULATORY COMMISSION STANDARD REVIEW PLAN

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 function of the spent fuel pool area ventilation system (SFPAVS) 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 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 General Design Criteria (GDCs) 2, 5, 60, and 61. The review includes such components as air intakes, ducts, air conditioning units, filters, blowers, isolation dampers, and exhaust fans. The review of the SFPAVS covers all areas containing or adjacent to the spent fuel pool, including the spent fuel pool cooling pump room.

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 loss of offsite power. 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.

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USNRC STANDARD REVIEW PLAN

This Standard Review Plan, NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The standard review plan sections are numbered in accordance with corresponding sections in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)". Not all sections of Regulatory Guide 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)".

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRR_SRP@nrc.gov.

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- 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.
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 SRP 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 SRP 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 sections interface with this section as follows:

- 1. Sections 3.2.1 and 3.2.2: determination of the acceptability of the seismic and quality group classifications for system components.
- 2. Sections 3.3.1, 3.3.2, 3.5.3, 3.7.1 through 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), and tornado missiles.
- 3. Sections 3.9.1 through 3.9.3: determination that components, piping, and structures are designed in accordance with applicable codes and standards.
- 4. Section 3.9.6: review of the adequacy of the inservice testing program of pumps and valves.
- 5. Section 3.10: review of the seismic qualification of Category I instrumentation and electrical equipment.

6. Section 3.11: review of the environmental qualification of mechanical and electrical equipment.
7. Section 6.6: verification that inservice inspection requirements are met for system components.
8. Sections 7.7 and 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.
9. Section 11.5: review and evaluation of the capability of the SFPAVS to detect and control leakage of radioactive contamination from the system.
10. Section 12.3-12.4: evaluation of radiation protection criteria.
11. Section 15.7.4: evaluation of the radiological consequences of airborne contaminants resulting from a fuel handling accident.
12. Section 16.0: review of proposed technical specifications.
13. Chapter 17: review of quality assurance programs.

The specific acceptance criteria and review procedures are contained in the referenced SRP sections.

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 5, "Sharing of Structures, Systems, and Components," as related to shared systems and components important to safety.
3. 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.
4. 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.
5. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.
6. 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 Atomic Energy Act, and the NRC's regulations.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for the review described in this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations.

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 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).
3. 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 rev 2, the applicable regulatory position is C.2. For RG 1.52 rev 3, the applicable regulatory position is C.3. For RG 1.140 rev 1, the applicable regulatory positions are C.1 and C.2. For RG 1.140 rev 2, the applicable regulatory positions are C.2 and C.3.
4. 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.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this SRP 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 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, GDC 5 requires that its component parts 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.

3. 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.

4. 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.

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 SRP 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 construction permit or standard DC review to determine that the design criteria and bases and the preliminary design, as set forth in the preliminary SAR, meet the acceptance criteria of subsection II of this SRP section.

For the review of an operating license (OL) application, the procedures are used to verify that the initial design criteria and bases have been implemented appropriately in the final design as set forth in the final SAR. These procedures should be followed for the review of a DC and a COL application.

The procedures for OL or 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.

As a result of various SFPAVS designs proposed by applicants, there will be variations in system requirements. For the purpose of this SRP section, a typical system is assumed, which has fully redundant subsystems, each having an identical essential (safety features) portion. For deviations from this typical arrangement, the reviewer adjusts the review procedures below; however, the system design must comply with the relevant NRC requirements identified in Subsection II.

1. The SAR is reviewed to verify that the system description section and piping and instrumentation diagrams (P&IDs) show the SFPAVS equipment used for normal operation and the ambient temperature limits for the area serviced. 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.

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," and American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) AG-1-1985, "Code on Nuclear Air and Gas Treatment."

2. The system P&IDs, layout drawings, and component descriptions and characteristics 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 P&IDs 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.

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 SAR that identify mechanical and performance characteristics are reviewed to verify that the above classifications have been included, and that the P&IDs 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 SAR 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.
3. 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 loss of offsite power. 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 SAR sections describing site features and the general arrangement and layout drawings and the SAR tabulation of seismic design classifications for structures and systems will be necessary. Statements in the SAR 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 SRP 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 P&IDs 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 loss of offsite power. 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 SAR 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 SAR 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.
4. The descriptive information, P&IDs, SFPAVS drawings, and failure modes and effects analyses in the SAR 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 SAR to ensure function of required components, traces the availability of these components on system drawings, and checks that the SAR 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.
5. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the 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 (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).
6. For review of both DC and COL applications, SRP Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following 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, 5, 60, and 61. 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 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.
3. The applicant has met the requirements of GDC 60 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 rev 2, the applicable regulatory position is C.2. For RG 1.52 rev 3, the applicable regulatory position is C.3. For RG 1.140 rev 1, the applicable regulatory positions are C.1 and C.2. For RG 1.140 rev 2, the applicable regulatory positions are C.2 and C.3.
4. 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.

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 SRP 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 SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications submitted six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, GDC 2, "Design Bases for Protection Against Natural Phenomena."
2. 10 CFR Part 50, Appendix A, GDC 5, "Sharing of Structures, Systems, and Components."
3. 10 CFR Part 50, Appendix A, GDC 60, "Control of Releases of Radioactive Materials to the Environment."
4. 10 CFR Part 50, Appendix A, GDC 61, "Fuel Storage and Handling and Radioactivity Control."

5. RG 1.13, "Fuel Storage Facility Design Basis."
6. 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."
7. RG 1.29, "Seismic Design Classification."
8. RG 1.52, "Design, Testing, and Maintenance Criteria for Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."
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."

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.
