



U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.4.2

SPENT FUEL POOL AREA VENTILATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary and Power Conversion Systems Branch (APCSB)

Secondary - Accident Analysis Branch (AAB)
Mechanical Engineering Branch (MEB)
Materials Engineering Branch (MTEB)
Structural Engineering Branch (SEB)
Reactor Systems Branch (RSB)
Effluent Treatment Systems Branch (ETSB)
Electrical, Instrumentation and Control Systems Branch (EICSB)
Radiological Assessment Branch (RAB)

I. AREAS OF REVIEW

The function of the spent fuel pool area ventilation system (SFPAVS) is to maintain ventilation in the spent fuel pool equipment areas, to permit personnel access, and to control airborne radioactivity in the area during normal operation, anticipated operational transients, and following postulated fuel handling accidents.

The APCSB reviews the SFPAVS from air intake to the point of discharge where the system connects to the gaseous cleanup and treatment system or the station vents. The review includes components such 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 cooling pump room.

1. The APCSB reviews the SFPAVS to determine the safety significance of the system. Based on this determination, the safety-related part of the system is reviewed with respect to functional performance requirements during normal operation, during adverse environmental occurrences, and subsequent to postulated accidents including the loss of offsite power. The APCSB reviews safety-related portions of the system to assure that:
 - a. A single active failure cannot result in loss of the system functional performance capability.
 - b. Components and piping or ducting have sufficient physical separation or barriers to protect essential portions of the system from missiles and pipe whip.

USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to Revision 2 of the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20586.

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- c. Failures of non-seismic Category I equipment or components will not affect the SFPAVS.
2. The APCSB also reviews safety-related portions of the SFPAVS with respect to the following:
 - a. The capability to detect and monitor radiation levels in the pool area.
 - b. The capability to direct ventilation air from areas of low radioactivity to areas of potentially higher radioactivity.
 - c. The capability to detect the need for isolation and to isolate portions of the system in the event of failures or malfunctions.
 - d. The capability to actuate components not normally operating that are required to operate during accident conditions, and to provide necessary isolation.
3. The applicant's proposed technical specifications are reviewed for operating license applications as they relate to areas covered in this plan.

Secondary reviews are performed by other branches and the results used by the APCSB to complete the overall evaluation of the system. The ETSB verifies that the system functional performance conforms to acceptable limits for radioactivity release during normal operations. The RAB reviews the system capability to monitor radiation levels in the pool. RAB also verifies the system meets the radiation protection criteria. The SEB determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing or supporting the system to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB will, upon request, review the seismic qualification of components and confirm that the components, piping, and structures are designed in accordance with applicable codes and standards. The RSB determines that the assigned seismic and quality group classifications for system components are acceptable. The MTEB verifies that inservice inspection requirements are met for system components and, upon request, will verify the compatibility of the materials of construction with service conditions. The EICSB determines the adequacy of the design, installation, inspection, and testing of all essential electrical components. The AAB evaluates the radiological consequences resulting from a postulated fuel handling accident and the effectiveness of the filtration system to remove radioactive contaminants.

II. ACCEPTANCE CRITERIA

Acceptability of the SFPAVS design, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria and regulatory guides. An additional basis for determining the acceptability of the SFPAVS is the degree of similarity of the design with that for previously reviewed plants with satisfactory operating experience.

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

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3 of the SAR.
2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.
3. General Design Criterion 5, as related to shared systems and components important to safety.
4. General Design Criterion 60, as related to the handling of radioactive materials in the SFPAVS.
5. General Design Criterion 64, as related to the monitoring of gaseous releases through the SFPAVS.
6. Regulatory Guide 1.13, as related to the system capability to limit releases of radioactive contaminants to the environment.
7. Regulatory Guide 1.26, as related to the quality group classification of systems and components.
8. Regulatory Guide 1.29, as related to the seismic design classification of system components.
9. Regulatory Guide 1.52, as related to system design requirements, maximum system flow requirements, and system functional performance requirements.
10. Regulatory Guide 8.8, "Information Relevant to Maintaining Occupational Radiation Exposure As Low As Practicable (Nuclear Reactors)."
11. Branch Technical Positions SPCSB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping system outside containment.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in Section II of this plan. For the review of operating license (OL) applications, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The procedures for OL reviews include a determination that the content and intent of the technical specifications prepared by the applicant 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 review plan, a typical system is assumed which has fully redundant subsystems, each having an identical essential (safety features) portion. For cases where there are variations from this typical arrangement, the reviewer would adjust the review procedures given below. However, the system design would be required to meet the acceptance criteria given in Section II. The reviewer will select and emphasize material from this plan as may be appropriate for a particular case.

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, the ambient temperature limits for the area serviced, and the filtration capacity of the exhaust filters. 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 describes the 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.
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 non-essential portions of the system. The P&IDs 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 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 non-essential portions and components from the essential portions.
 - b. Essential portions of the SFPAVS, including the isolation dampers separating essential from non-essential portions, are classified Quality Group C or higher and 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. It 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 in the event of certain pipe breaks or loss of offsite power. The reviewer evaluates the system, using engineering judgement and failure modes and effects analyses to determine that:
- a. The failure of non-essential 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 non-seismic 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 will be necessary, as well as the SAR tabulation of seismic design classifications for structures and systems.
 - b. The essential portions of the SFPAVS are protected from the effects of floods, hurricanes, tornadoes, and internally and externally generated missiles. Flood protection and missile protection criteria are discussed and evaluated in detail in Chapter 3 of the SAR. 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 seismic Category I structure that is tornado missile and flood protected, 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. It is acceptable if the following conditions are met:
 - (1) The system PID's delineate the location of monitors and alarms in the system that are capable of detecting and warning of radiation from the fuel pool area.
 - (2) The capability for isolating non-essential portions of the SFPAVS by two automatically actuated dampers in series is shown on the P&IDs.
 - (3) 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. A statement in the SAR that the technical specifications will require that the SFPAVS be operating whenever fuel handling operations are in progress is required.
 - d. The essential portions of the system are protected from the effects of high and moderate energy line breaks. Layout drawings are reviewed to assure that no high

or moderate energy piping systems are close to essential portions of the SFPAVS, or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR and procedures for reviewing this information are given in the corresponding review plans.

- e. 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 see 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 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 assure 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 assure 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.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and his review supports conclusions of the following type, to be included in the staff's safety evaluation report:

"The spent fuel pool area ventilation system (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. The scope of the review of the SFPAVS for the _____ plant included layout drawings, piping and instrumentation diagrams, and descriptive information for the system and the supporting systems that are essential to its safe operation. [The review has determined the adequacy of the applicant's proposed design criteria and design bases for the spent fuel pool area ventilation system and the requirements for system performance to prevent an unacceptable release of contaminants to the environment during normal, abnormal, and accident conditions. (CP)] [The review has determined that the design of the spent fuel pool area ventilation system and supporting systems is in conformance with the design criteria and design bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs, design criteria, and design bases for the SFPAVS and its supporting systems to the Commission's regulations as set forth in the general design criteria, and to applicable regulatory guides, staff technical positions, and industry standards.

"The staff concludes that the design of the SFPAVS conforms to all applicable regulations, guides, staff positions, and industry standards, and is acceptable."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."
2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."
3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."
4. 10 CFR Part 50, Appendix A, General Design Criterion 60, "Control of Releases of Radioactive Materials to the Environment."
5. 10 CFR Part 50, Appendix A, General Design Criterion 64, "Monitoring Radioactivity Releases."
6. Regulatory Guide 1.13, "Fuel Storage Facility Design Basis."
7. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Revision 1.
8. Regulatory Guide 1.29, "Seismic Design Classification," Revision 1.
9. Regulatory Guide 1.52, "Design, Testing, and Maintenance Criteria for Atmosphere Clean-up System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."
10. Regulatory Guide 8.8, "Information Relevant to Maintaining Occupational Radiation Exposure As Low As Practicable (Nuclear Reactors)."
11. Branch Technical Positions APCS 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to Standard Review Plan 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to Standard Review Plan 3.6.2.

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