U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

9.4.2 SPENT FUEL POOL AREA VENTILATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - None

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 ASB 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 to assure conformance with the requirements of General Design Criteria 2, 60, and 61. 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 ASB 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 ASB 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. Failures of nonseismic Category I equipment or components will not affect the SFPAVS.

2. The ASB also reviews safety-related portions of the SFPAVS with respect to 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. The ASB also performs the following reviews under the SRP sections indicated:

a. Review of flood protection is performed under SRP Section 3.4.1.

b. Review of the protection against internally-generated missiles is performed under SRP Section 3.5.1.1.

c. Review of the structures, systems, and components to be protected against externally-generated missiles is performed under SRP Section 3.5.2.

d. Review of high and moderate energy pipe breaks is performed under SRP Section 3.6.1.

The ASB will coordinate evaluations performed by other branches that interface with ASB to complete the overall evaluation of the system as follows: The Instrumentation and Control Systems Branch (ICSB) and the Power Systems Branch (PSB) determine the adequacy of the design, installation, inspection, and testing of all essential electrical components (sensing, control and power) required for proper operation as part of their primary review responsibility for SRP Sections 7.7 and 8.3.1 respectively. The Structural Engineering Branch (SEB) determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probably maximum flood (PMF), and tornado missiles as part of its primary review responsibility for SRP Sections 3.3.1, 3.3.2, 3.5.3, 3.7.1 thru 3.7.4, 3.8.4, and 3.8.5. The Mechanical Engineering Branch (MEB) determines that the components, piping, and structures are designed in accordance with applicable codes and standards as part of its primary review responsibility for SRP Sections 3.9.1 thru 3.9.3. The MEB, also, determines the acceptability of the seismic and quality group classifications for system components as part of its primary review responsibility for SRP Sections 3.2.1 and 3.2.2. The MEB also reviews the adequacy of the inservice testing program of pumps and valves as part of its primary review responsibility for SRP Section 3.9.6. The Materials Engineering Branch (MTEB) verifies that inservice inspection requirements are met for system components as part of its primary review responsibility for SRP Section 6.6. The Effluent Treatment Systems Branch (ETSB) evaluates the system functional performance to assure that the system meets acceptable limits for radioactive releases during normal operations as part of its primary review responsibility for SRP Section 11.3. The Radiological Assessment Branch (RAB) evaluates the radiation protection criteria as part of its primary review responsibility for SRP Section 12.3. The Equipment Qualification Branch (EQB) reviews the seismic qualification of Category I instrumentation and electrical equipment, and the environmental qualification of mechanical equipment as part of its primary responsibility

for SRP Sections 3.10 and 3.11 respectively. The ETSB evaluates the effectiveness of the SFPAVS filters to remove airborne contaminants prior to discharge to the environment in SRP Section 6.5.1. The Accident Evaluation Branch (AEB) evaluates the radiological consequences of airborne contaminants resulting from a fuel handling accident as part of its primary review responsibility for SRP Section 15.7.4. The ETSB also reviews and evaluates the capability of the SFPAVS to detect and control leakage of radioactive contamination from the system. The review for fire protection, technical specifications, and quality assurance are coordinated and performed by the Chemical Engineering Branch, Licensing Guidance Branch, and Quality Assurance Branch as part of their primary review responsibility for SRP Sections 9.5.1, 16.0, and 17.0 respectively.

For those areas of review identified above as being reviewed as part of the primary review responsibility of other branches, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section of the corresponding primary branch.

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.

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 the system being capable of withstanding the effects of earthquakes. Acceptance is based on meeting the guidance of Regulatory Guide 1.29, Position C.1 for safety-related portions and Position C.2 for nonsafety-related portions.

2. General Design Criterion 5, as related to shared systems and components important to safety.

3. General Design Criterion 60, as related to the systems capability to suitably control release of gaseous radioactive effluents to the environment. Acceptance is based on meeting the guidance of Regulatory Guides 1.52 and 1.140, as related to design, testing, and maintenance criteria for atmosphere cleanup system and normal ventilation exhaust system air filtration and adsorption units of light-water-cooled nuclear power plants, Position C.2, and Positions C.1 and C.2 respectively.

4. General Design Criterion 61, as related to the systems 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. Acceptance is based on meeting the guidance of Regulatory Guide 1.13, as related to the design of the ventilation system for the spent fuel storage facility, Position C.4.

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 subsection II of this SRP section.

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 primary reviewer will coordinate this review with the other areas of review as stated in subsection I of this SRP section. The primary reviewer obtains and uses such inputs as required to assure that this review procedure is complete.

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 cases where there are variations from this typical arrangment, the reviewer would adjust the review procedures given below. However, the system design would be required to meet the acceptance criteria given in subsection II of this SRP section. The reviewer will select and emphasize material from this SRP section 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 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 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 nonessential 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 nonessential portions and components from the essential portions. The review for seismic design is performed by SEB and the review for quality group and seismic classification is performed by MEB as indicated in subsection I of this SRP section.

   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. 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 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 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 the Section 3 series of the SRP. 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 capability for isolating nonessential portions of the SFPAVS by two automatically actuated dampers in series is shown in the P&IDs.

      (2) 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 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. All portions of the system whose failure may result in release of radioactivity which causes an offsite dose of more than 0.5 rem to the whole body or its equivalent 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 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, the staff concludes that the design of the spent fuel pool area ventilation system and supporting systems is acceptable and meets the Commission's regulations as set forth in General Design Criteria 2, 5, 60, and 61.

This conclusion is based on the following:

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 Regulatory Guide 1.29, 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 Regulatory Guide 1.52, Position C.2, and Regulatory Guide 1.140, Positions C.1 and C.2.

4. The applicant has met the requirements of GDC 61 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 Regulatory Guide 1.13, Position C.4.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides.

VI. 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 5, "Sharing of Structures, Systems, and Components."

3. 10 CFR Part 50, Appendix A, General Design Criterion 60, "Control of Releases of Radioactive Materials to the Environment."

4. 10 CFR Part 50, Appendix A, General Design Criterion 61, "Fuel Storage and Handling and Radioactivity Control."

5. Regulatory Guide 1.13, "Fuel Storage Facility Design Basis."

6. Regulatory Guide 1.29, "Seismic Design Classification."

7. Regulatory Guide 1.52, "Design, Testing, and Maintenance Criteria for Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."

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