U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

9.4.5 ENGINEERED SAFETY FEATURE VENTILATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - None

I. AREAS OF REVIEW

The function of the engineered safety feature ventilation system (ESFVS) is to provide a suitable and controlled environment for engineered safety feature components following certain anticipated transients and design basis accidents.

The ASB reviews the ESFVS from air intake to the point of discharge to the atmosphere to assure conformance with the requirements of General Design Criteria 2, 4, 5, 17, and 60. The review includes components such as air intakes, ducts, air conditioning units, flow control devices, isolation dampers, exhaust vents, and exhaust fans.

The review of the ESFVS covers all ventilation systems utilized to maintain a controlled environment in areas containing safety-related equipment. These include the service water pump house, diesel generator area, emergency core cooling system (ECCS) pump rooms, component cooling water pump room, auxiliary feedwater pump area, and other areas containing equipment essential for the safe shutdown of the reactor or necessary to prevent or mitigate the consequences of an accident.

1. The ASB reviews the ESFVS to determine the safety significance of the various portions and subsystems. Based on this determination, the safety-related portions of the system are reviewed with respect to functional performance requirements associated with engineered safety feature areas during normal operation, during adverse environmental occurrences, and during 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 capabilities.

b. Failures of nonseismic Category I equipment or components will not result in damage to essential portions of the ESFVS.

2. The ASB also reviews safety-related portions of the ESFVS with respect to the following:

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

   b. Provisions to detect the need for isolation and to isolate portions of the system in the event of failures or malfunctions.

   c. The ability of the safety features equipment in the areas being serviced by the ventilation system to function under the worst anticipated degraded ESFVS system performance.

   d. Capability of the system to circulate sufficient air to prevent accumulation of inflammable or explosive gas or fuel-vapor mixtures from components such as storage batteries and stored fuel.

   e. The capability of the system to automatically actuate compoments not operating during normal conditions, or to actuate standby components (redundant equipment) in the event of a failure or malfunction, as needed.

   f. The capability of the system to control airborne particulate material (dust) accumulation.

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 the overall evaluation of the system as follows. The ICSB and PSB determine the adequacy of the design, installation, inspection, and testing of all electrical components (sensing, control, and power) required for proper operation as part of their primary review responsibility for SRP Sections 7.3 and 8.3.1, respectively. The 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 probable 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 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.

In the event that the system is utilized for the purpose of supplying combustion air as well as providing a ventilation function, the PSB reviews the acceptability for that portion of the system as part of its primary review responsibility for SRP Section 9.5.8. The Accident Evaluation Branch (AEB) evaluates the radiological consequences of airborne contaminants resulting from accident conditions (see Appendix B to SRP Section 15.6.5). The ETSB evaluates the effectiveness of the ESFVS filters to remove airborne contaminants prior to discharge to the environment (see SRP Section 6.5.1). ETSB also reviews and evaluates the capability of the ESFVS to detect and control leakage of radioactive contamination from the system as described in SRP Section 11.5. 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 ESFVS 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 ESFVS is acceptable if the integrated design of the systems 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 C.2 for nonsafety-related portions.

2. General Design Criterion 4, with respect to maintaining environmental conditions in essential areas compatible with the design limits of the essential equipment located therein during normal, transient, and accident conditions.

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

4. General Design Criterion 17, as related to assuring proper functioning of the essential electric power system. Acceptance is based on meeting the guidance of item 2 under subsection A and item 1 under subsection C of the section on "Recommendations" of NUREG-CR/0660 (Ref. 9) relating to the protection of essential electrical components from failure due to the accumulation of dust and particulate materials.

5. 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.

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. For the review of operating license (OL) applications, the procedures are utilized 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 branches' areas of review as stated in subsection I. The primary reviewer obtains and uses such inputs as required to assure that this review procedure is complete.

As a result of various ESFVS 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 arrangement, 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. 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 and piping and instrumentation diagrams (P&IDs) show the ESFVS equipment used for normal operation, and the ambient temperature limits for the areas serviced. The system performance requirements are reviewed to determine that they limit allowable component operational degradation (e.g., loss of function, damper leakage) and describe the procedures that will be followed to detect and correct these conditions. The reviewer, using results from failure modes and effects analyses as appropriate, will determine that the safety-related portion of the system is capable of sustaining the failure 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 ESFVS 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 see 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.

b. Essential portions of the ESFVS, 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 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 the results of failure modes and effects analyses, to determine that:

a. The failure of nonessential portions of the system or of other nonseismic systems, components, or structures located close to essential portions of the system will not preclude operation of the essential portions of the ESFVS. 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 ESFVS 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 under 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 provided 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 airborne contamination from the system. It is acceptable if the following conditions are met:

(1) The capability for isolating nonessential portions of the ESFVS by two automatically actuated isolation dampers in series is shown on the P&IDs.

(2) The ESFVS has provisions to actuate ventilation equipment in the engineered safety feature areas before ambient temperatures exceed design rated temperatures of components.

d. Essential components and subsystems can function as required in the event of loss of offsite power. The system design will be acceptable if the ESFVS 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 ESFVS component or subsystem affected by the loss of offsite power, the resulting system performance will not affect the capability of any engineered safety feature equipment. Statements in the SAR and 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, ESFVS 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.

5. The ESFVS is reviewed to assure that adequate means is provided in the system design for control of airborne particulate material (dust) accumulation. The system arrangement is reviewed to verify that a minimum of 20 feet exists from the bottom of all fresh air intakes to grade elevation, or that electrical cabinets are provided with suitable seals or gaskets.

IV. EVALUATION FINDINGS

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

> The engineered safety feature ventilation system (ESFVS) includes all components and ducting associated with the system from air intake to the point of discharge to the atmosphere. 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 are 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 engineered safety feature ventilation system, and the requirements for system performance to preclude equipment malfunction in

the engineered safety feature areas due to a failure of the system during normal, abnormal, and accident conditions, the staff concludes that the design of the engineered safety feature ventilation system and supporting systems is acceptable and meets the Commission's regulations as set forth in General Design Criteria 2, 4, 5, 17, and 60.

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, "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 environmental requirements of GDC 4 by maintaining environmental conditions in essential areas within the design limits of the essential equipment located in these areas for normal, transient, or accident conditions.

3. The applicant has met the requirements of GDC 5 with respect to capability of shared systems and components important to safety to perform required safety functions since no postulated single active failure will prevent the system from performing its safety function.

4. The applicant has met the requirements of GDC 17 as related to assuring proper functioning of the essential electric power system by meeting the guidelines of NUREG-CR/0660 as related to the accumulation of dust and particulate materials.

5. 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, "Design, Testing and Maintenance Criteria for Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants," Position C.2, and 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," Positions C.1 and C.2.

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 and NUREG. The implementation of new position 5 under subsection III is applicable only to CP applications.

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 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 17, "Electric Power Systems."

5. 10 CFR Part 50, Appendix A, General Design Criterion 60, "Control of Releases of Radioactive Materials to the Environment."

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."

9. NUREG-CR/0660, "Enhancement of Onsite Emergency Diesel Generator Reliability."