



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

SECTION 9.4.5

ENGINEERED SAFETY FEATURE VENTILATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary and Power Conversion Systems Branch (APCSB)

Secondary - Electrical, Instrumentation and Control Systems Branch (EICSB)
 Mechanical Engineering Branch (MEB)
 Materials Engineering Branch (MTEB)
 Structural Engineering Branch (SEB)
 Reactor Systems Branch (RSB)

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 APCSB reviews the ESFVS from air intake to the point of discharge to the atmosphere. 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 APCSB 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 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 capabilities.

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. 20506.

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- b. Components and piping or ducting have sufficient physical separation or barriers to protect essential portions of the system from missiles and pipe whip.
 - c. Failures of non-seismic Category I equipment or components will not result in damage to essential portions of the ESFVS.
2. The APCSB 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. Capability to detect leakage of radioactivity or airborne contaminants from the engineered safety feature areas, and the ability to isolate the system to prevent uncontrolled discharge to the environment.
 - c. Provisions to detect the need for isolation and to isolate portions of the system in the event of failures or malfunctions.
 - d. 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.
 - e. 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.
 - f. The capability of the system to automatically actuate components not operating during normal conditions, or to actuate standby component (redundant equipment) in the event of a failure or malfunction, as needed.
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 are used by the APCSB to complete the overall evaluation of the system. The SEB determines the acceptability of 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. The MEB reviews the seismic qualification of components and confirms that 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 will verify 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 electrical components required for proper operation.

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. An additional basis for determining the acceptability of the ESFVS 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 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 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. Regulatory Guide 1.26, as related to the quality group classification of system components.
5. Regulatory Guide 1.29, as related to the seismic design classification of system components.
6. Regulatory Guide 1.52, as related to system design requirements, maximum system flow requirements, and system functional performance requirements.
7. Branch Technical Positions APCSB 3-1, and MEB 3-1, as related to breaks in high and moderate energy piping systems 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 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 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 ESFVS 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 review 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 ESFVS equipment used for normal operation, the ambient temperature limits for the areas serviced, and the filtration capacity of the intake and exhaust filters. The system performance requirements section is reviewed to determine that it limits 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 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 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 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 non-essential portions and components from the essential portions.
 - b. Essential portions of the ESFVS, 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 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 judgment and the results of failure modes and effects analyses to determine that:

- a. The failure of non-essential portions of the system or of other non-seismic 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 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 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 system P&ID shows monitors and alarms located in the system that are capable of detecting and warning of radioactive contaminants. Smoke detection may be required in special cases, such as for fires resulting from aircraft crashes.
 - (2) The capability for isolating non-essential portions of the ESFVS by two automatically actuated dampers in series is shown on the P&IDs.
 - (3) The ESFVS has provisions to actuate ventilation equipment in the engineered safety feature areas before ambient temperatures exceed design rated temperatures of components.
- 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 ESFVS 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. 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.

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. The scope of review of the ESFVS 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 determined the adequacy of the applicant's proposed design criteria and design bases 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. (CP)] [The review has determined that the design of the engineered safety feature ventilation system and supporting systems is in conformance with the proposed design criteria and 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 ESFVS and its supporting systems to the Commission's regulations as set forth in the general design criteria, and to applicable regulatory guides, branch technical positions, and industry standards.

"The staff concludes that the design of the ESFVS 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. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam- and Radioactive-Waste-Containing Components of Nuclear Power Plants."
5. Regulatory Guide 1.29, "Seismic Design Classification."
6. Regulatory Guide 1.52, "Design, Testing, and Maintenance Criteria for Atmosphere Cleanup System Air Filtration and Adsorption Units for Light-Water-Cooled Nuclear Power Plants."
7. Branch Technical Positions APCSB 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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