U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

9.4.1 CONTROL ROOM AREA VENTILATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - None

I. AREAS OF REVIEW

The function of the control room area ventilation system (CRAVS) is to provide a controlled environment for the comfort and safety of control room personnel and to assure the operability of control room components during normal operating, anticipated operational transient, and design basis accident conditions.

The ASB reviews the CRAVS from the air intake to the point of discharge where the system connects to the gaseous cleanup and treatment system or station vents to assure conformance with the requirements of General Design Criteria 2, 4, 5, 19 and 60. The review includes components such as air intakes, ducts, air conditioning units, filters, blowers, isolation dampers or valves, and exhaust fans. The review of the CRAVS covers the control room, switchgear and battery room, access control area, control building heating, ventilating, and air conditioning (HVAC) equipment room, and computer room.

1. The ASB reviews the CRAVS to determine the safety significance of the system. Based on this determination, the safety-related portions of the system are reviewed with respect to the functional performance requirements to maintain the habitability of the control room area and other safety-related areas served by the control room ventilation system during adverse environmental occurrences, during normal operation, anticipated operational occurrences, and subsequent to postulated accidents. The review includes the effects of radiation, combustion and other toxic products, and the coincidental 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 CRAVS.

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

   a. The ability of the control room heating and cooling subsystems to maintain a suitable ambient temperature for control room personnel and equipment.

   b. The ability to detect, filter, or expedite safe discharge of airborne contaminants inside the control room.

   c. The provisions for the detection and isolation of portions of the system in the event of fires, failures, or malfunctions.

   d. The ability of essential equipment being serviced by the ventilation system to function under the worst anticipated degraded CRAVS performance.

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 Instrumentation and Control Systems Branch (ICSB) and 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 7.3 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 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 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.

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 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. The Effluent Treatment Systems Branch (ETSB) evaluates the effectiveness of the system filters to remove airborne contaminants prior to discharge to the environment as part of its primary review responsibility for SRP Section 6.5.1. The Accident Evaluation Branch (AEB) evaluates the concentrations of airborne contaminants in the vicinity of the intake and exhaust vents resulting from accidental release on the plant site and evaluates the capability of the system to maintain control room habitability as part of its primary review responsibility for SRP Section 6.4. The Equipment Qualification Branch (EQB) reviews the seismic qualification of Category I electrical components and the environmental qualification of mechanical and electrical components as part of its primary review responsibility for SRP Sections 3.10 and 3.11, 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 CRAVS 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 CRAVS 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 4, with respect to maintaining environmental conditions in the control room compatible with the design limits of 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 19, as related to providing adequate protection to permit access and occupancy of the control room under accident conditions. Acceptance is based on meeting the guidance of Regulatory Guide 1.78 relating to instrumentation to detect and alarm any hazardous chemical release in the plant vicinity and relating to the systems capability to isolate the control room from such releases and the systems capability to meet the single failure criterion, positions C.3, C.7, and C.14, respectively; and Regulatory Guide 1.95 relating to the systems capability to limit the accumulation of chlorine within the control room and the systems capability to meet the single failure criterion, positions C.4a and C.4d.

Regulatory Guide 1.95 relating to the systems capability to limit the accumulation of chlorine within the control room and the systems capability to meet the single failure criterion, positions C.4a and C.4d.

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 of this SRP section. For the review of operating license 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 input as required to assure that this review procedure is complete.

As a result of various CRAVS designs proposed by applicants, there will be variations in system requirements. For the purpose of this SRP section, a typical system with redundant subsystems is assumed with each subsystem 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 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 and piping and instrumentation diagrams (P&IDs) show the CRAVS equipment used for normal and emergency operations, and the ambient temperature limits for the areas 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, 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 CRAVS 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 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.

b. Essential portions of the CRAVS, 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. The review for seismic design is performed by SEB and the review for seismic and quality group classification is performed by MEB as indicated in subsection I of the SRP section.

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 pumps or isolation valves 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 nonessential systems, structures, or components located close to essential portions of the system will not preclude operation of the essential portions of the CRAVS. 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. Statements in the SAR that verify that the above conditions will be met are acceptable at the CP stage.

b. The essential portions of the CRAVS are protected from the effects of floods, hurricanes, tornadoes, and internally or 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 pump 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 seismic Category I 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 into the system. It is acceptable if the following conditions are met:

(1) The system P&IDs show monitors located in the system intakes that are capable of detecting radiation, smoke, and toxic chemicals. The monitors should actuate alarms in the control room.

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

(3) The CRAVS has provisions for an internal recirculation filtering mode of operation or can discharge airborne contaminants from the control room area using a once-through ventilation mode, as applicable.

(4) Provisions for isolation of the control room upon smoke detection at the air intakes are shown on the P&IDs. The isolation may be actuated manually for most cases. Automatic isolation may be required in special cases such as for fires resulting from aircraft crashes.

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 CRAVS 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 CRAVS component or subsystem affected by the loss of offsite power, the resulting system operation will not affect safety of control room personnel or the performance of any essential equipment. 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, CRAVS 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 situtation 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 control room area ventilation system (CRAVS) includes all components and ducting from the intake vents to the exhaust structure. 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, the design bases, and safety classification for the control room area ventilation system, and the requirements for system performance to maintain a suitable environment during normal, abnormal, and accident conditions, the staff concludes that the design of the control room area ventilation

system and auxiliary supporting systems is in conformance with the Commission's regulations as set forth in General Design Criteria 2, 4, 5, 19, and 60. This conclusion is based on the following:

1. The applicant has met the requirements of General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," 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 requirements of General Design Criterion 4, "Environmental and Missile Design Basis," by maintaining environmental conditions in the control room within the design limits of the essential equipment located therein for normal, transient, or accident conditions.

3. The applicant has met the requirements of General Design Criterion 5, "Sharing of Structures, Systems, and Components Important to Safety to Perform Required Safety Functions," with respect to capability of shared systems and components important to safety to perform required safety functions.

4. The applicant has met the requirements of General Design Criterion 19, "Control Room," with respect to the capability of the system to maintain a suitable environment in the control room for occupancy during normal and accident conditions by meeting the guidelines of Regulatory Guide 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," positions C.3, C.7, and C.14, and Regulatory Guide 1.95, "Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release," positions C.4a and C.4d.

5. The applicant has met the requirements of General Design Criterion 60, "Control of Releases of Radioactive Materials to the Environment," 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.

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 19, "Control Room."

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 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release."

9. Regulatory Guide 1.95, "Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release."

10. 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."