



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

SECTION 9.4.1

CONTROL ROOM AREA VENTILATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary and Power Conversion Systems Branch (APCSB)

Secondary - Electrical, Instrumentation and Control Systems Branch (EICSB)

Mechanical Engineering Branch (MEB)
 Structural Engineering Branch (SEB)
 Materials Engineering Branch (MTEB)
 Reactor Systems Branch (RSB)
 Accident Analysis Branch (AAB)
 Effluent Treatment Systems Branch (ETSB)

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 main control room personnel and to assure the operability of main control room components during normal operating, anticipated operational transient, and design basis accident conditions.

The APCSB 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. The review includes components such as air intakes, ducts, air conditioning units, filters, blowers, isolation dampers or valves, and exhaust fan. 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 APCSB reviews the CRAVS to determine the safety significance of the system. Based on this determination, the safety-related part of the system is reviewed with respect to the functional performance required to maintain a habitable control room area 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 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 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 affect the CRAVS.

 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. 20555.

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2. The APCSB 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 capability to detect in-leakage of radioactivity or airborne chemical contaminants to the control room and the ability to isolate the system to preclude their entrance.
 - c. The ability to detect, filter, or expedite safe discharge of airborne contaminants inside the control room.
 - d. The provisions for the detection and isolation of portions of the system in the event of fires, failures, or malfunctions.
 - e. The ability of essential equipment being serviced by the ventilation system to function under the worst anticipated degraded CRAVS performance.
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 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. The MEB, upon request, 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 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 concentrations of airborne contaminants in the vicinity of the intake and exhaust vents resulting from accident releases on the plant site. The ETSB verifies the effectiveness of the CRAVS filtration system to remove radioactive and chemical contaminants.

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. An additional basis for determining the acceptability of the CRAVS 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 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 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 19, as related to providing adequate protection to permit access and occupancy of the control room under accident conditions.
5. Regulatory Guide 1.26, as related to the quality group classification of systems and components.
6. Regulatory Guide 1.29, as related to the seismic design classification of system components.
7. Regulatory Guide 1.52, as related to system design requirements, maximum system flow requirements, system functional performance requirements, design provisions for radiation detection, and isolation provisions.
8. Regulatory Guide 1.95 "Protection of Nuclear Power Plant Control Room Operators Against An Accidental Chlorine Release."
9. Branch Technical Positions APCS 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 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 proposed technical specifications 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 CRAVS designs proposed by applicants, there will be variations in system requirements. For the purpose of this review plan, 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 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 and piping and instrumentation diagrams (PID's) show the CRAVS equipment used for normal operation, the ambient temperature limits for the areas serviced, and the filtration capacities of the intake and 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, 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 PID's, 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 non-essential portions of the system. The PID's 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 non-essential portions and components from the essential portions.
 - b. Essential portions of the CRAVS, 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 PID's 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 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 in the event of certain pipe breaks or loss of orfsite 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-essential 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 are met are acceptable. (CP)
- 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 in Chapter 3 of the SAR. 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 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 PID's 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 non-essential portions of the CRAVS by two automatically actuated dampers in series is shown on the PID's.
 - (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 PID's. 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. 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 CRAVS, 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 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 control room 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, PID's, 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 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 control room area ventilation system (CRAVS) includes all components and ducting from the intake vents to the exhaust structure. The scope of review of the CRAVS for the _____ plant included layout drawings, piping and instrumentation diagrams, and descriptive information for the system and the auxiliary supporting systems that are essential to its operation. [The review has determined the adequacy of the applicant's proposed design criteria and design bases for the control room area ventilation system and the requirements for system performance to maintain a suitable environment during all normal, abnormal, and accident conditions. (CP)] [The review has determined that the design of the control room area ventilation system and auxiliary supporting systems is in conformance with the design criteria and bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs and design criteria for the CRAVS and necessary auxiliary 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 CRAVS 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 19, "Control Room."
5. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Revision 1.
6. Regulatory Guide 1.29, "Seismic Design Classification."
7. Regulatory Guide 1.95, "Protection of Nuclear Power Plant Control Room Operators Against An Accidental Chlorine Release."
8. 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."
9. Branch Technical Positions APCS 3-1, "Protection Against Postulated Piping Failure 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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