



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

9.5.8 EMERGENCY DIESEL ENGINE COMBUSTION AIR INTAKE AND EXHAUST SYSTEM

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - None

I. AREAS OF REVIEW

The emergency diesel engine combustion air intake and exhaust system (EDECAIES) supplies combustion air of reliable quality to the diesel engines, and exhausts the products of combustion from the diesel engines to the atmosphere. The PSB reviews the system from the outside air intake to the combustion air supply lines connected to the diesel engine interface,¹ and from the exhaust connections at the diesel engine interface¹ to the discharge point outside the building to assure conformance with General Design Criteria 2, 4, 5, and 17.

1. The PSB reviews the EDECAIES to verify that:

- a. The system design meets appropriate seismic design classification requirements and the components are designed, fabricated, erected, and tested to acceptable quality standards.
- b. The essential portions of the system are housed in or on a seismic Category I structure that is capable of protecting the system from extreme natural phenomena and external missiles.
- c. Each diesel engine has an independent combustion air intake and exhaust system.
- d. The consequences of a single active failure in an engine combustion air intake or exhaust system will not lead to the loss of function of more than one diesel generator.

2. The PSB will determine the adequacy of the design, installation, inspection and testing of all electrical systems (sensing, control and power) required

¹As defined by the engine manufacturer.

Rev. 2

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 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.

for proper system operation and will evaluate the protection provided to the electrical system from dust accumulation in SRP Section 8.3.1.

In the review of the EDECAIES, the PSB will coordinate other branches' evaluations that interface with the overall review of the system as follows: 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 through 3.7.4, 3.8.4, and 3.8.5. The Mechanical Engineering Branch (MEB) determines that system 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 through 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 Auxiliary Systems Branch (ASB) determines that the EDECAIES is in accordance with Branch Technical Position ASB 3-1 and MEB 3-1 for cracks and breaks in high-energy and moderate-energy piping systems outside containment as part of its primary review responsibility for SRP Section 3.6.1. In the case of the diesel generator building ventilation system supplying the combustion air as well as building ventilation, the ASB, upon request, determines that the ventilation system meets the criteria of this SRP section as part of its primary review responsibility for SRP Section 9.4.5. The Materials Engineering Branch (MTEB) verifies, upon request, the compatibility of the materials of construction with service conditions. The Procedures and Test Review Branch determines the acceptability of the preoperational and startup tests as part of its primary review responsibility for SRP Section 14.0.

The reviews 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 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 branches.

II. ACCEPTANCE CRITERIA

Acceptability of the design of the emergency diesel generator combustion air intake and exhaust system, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria and regulatory guides and industry standards. Information obtained from other Federal agencies and reports, military specifications, available technical literature, and operational performance data obtained from similarly designed systems at other plants having satisfactory operational experience will also be utilized to determine EDECAIES acceptability.

The design of the EDECAIES 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 ability of structures housing the system and system components to withstand the effects of natural phenomena

such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3 of the SAR. Acceptance is based on meeting Appendix Position 13 of Regulatory Guide 1.117 as related to the protection of structures, systems, and components important to safety from the effects of tornado missiles.

2. General Design Criterion 4, with respect to structures housing the systems and the system components being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks. Acceptance is based on meeting Position C.1 of Regulatory Guide 1.115 as related to the protection of structures, systems, and components important to safety from the effects of turbine missiles.
3. General Design Criterion 5, as related to shared systems and components important to safety being capable of performing required safety functions.
4. General Design Criterion 17 as related to the capability of the diesel engine air starting system to meet independence and redundancy criteria. Acceptance is based on meeting the following specific criteria:
 - a. Regulatory Guide 1.9 as related to the design of the diesel engine combustion air intake and exhaust systems.
 - b. Branch Technical Position ICSB-17 (PSB) as related to diesel engine combustion air intake and exhaust systems' protective interlocks during accident conditions.
 - c. NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability."
 - d. IEEE Standard 387 as related to the design of the diesel engine combustion air intake and exhaust system.
 - e. Diesel Engine Manufacturers Association (DEMA) Standard as related to the design of the diesel combustion air intake and exhaust system.
 - f. Each emergency diesel engine should be provided with an independent and reliable combustion air intake and exhaust system. The system should be sized and physically arranged such that no degradation of engine function will be experienced when the diesel generator set is required to operate continuously at the maximum rated power output.
 - g. The combustion air intake system shall be provided with a means of reducing airborne particulate material over the entire time period that emergency power is required assuming the maximum airborne particulate concentration at the combustion air intake.
 - h. Suitable design precautions have been taken to preclude degradation of the diesel engine power output due to exhaust gases and other dilutents that could reduce the oxygen content below acceptable levels.

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 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 review procedures for OL applications 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 LGB review, as indicated in subsection I of this SRP section.

The primary reviewer will coordinate this review with the other branches' areas of review 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.

The reviewer will select and emphasize material from the paragraphs below, as may be appropriate for a particular case.

1. The SAR is reviewed to determine that the EDECAIES is a dedicated system and that the description and related diagrams clearly delineate the system components and the modes of system operation. The SEB reviews the seismic design bases and the MEB reviews the quality and seismic classification as indicated in subsection I of this SRP section. The PSB assures that essential portions of the EDECAIES are classified Quality Group C and seismic Category I. Components and system descriptions in the SAR that identify mechanical and performance characteristics are reviewed to verify that the above seismic and quality classifications have been included and that the P&IDs indicate any points of change at the system and/or system component interfaces.
2. The SAR is reviewed to ascertain that sufficient space has been provided around the components to permit inspection of the system components.
3. The SAR is reviewed to assure that the arrangement and location of the combustion air intake and exhaust are such that dilution or contamination of the intake air by exhaust products, fire extinguishing (gaseous) medium, or other gases that may intentionally or accidentally be released on site will not preclude operation of the diesel engines at rated power output, or cause engine shutdown as a consequence of any meteorological or accident condition.
4. The SAR is reviewed to verify that if the intake air flow or engine exhaust is dependent upon the actuation of flow control devices (louvers, dampers), the EDECAIES will function if there is a failure of an active component.
5. The SAR is reviewed to assure that system components exposed to atmospheric conditions (dust storms, rain, ice, snow) are protected from possible clogging during standby or operation of the system.
6. The reviewer verifies that the system will function as required in the event of other adverse natural phenomena. 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 system or of other systems not designed to seismic Category I requirements and located close to essential portions of the system, or of non-seismic Category I structures that house, support, or are close to essential portions of the EDECAIES, will not preclude operation of the system. 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.
 - b. The essential portions of the system 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 SRP sections for Chapter 3 of the SAR. The location and the design of the systems and structures 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 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 the essential portions of the system, 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 SRP sections.
7. The descriptive information, P&IDs, EDECAIES layout drawings, and failure modes and effects analyses in the SAR are reviewed to assure that functional requirements of the system will be met following design basis accidents assuming a concurrent single active component failure. The reviewer evaluates the effects of failure of components, traces the availability of redundant components on system drawings, and checks that the SAR contains verification that the system functional requirements are met.
 8. The SAR is reviewed to assure that provisions have been made in the diesel generator combustion air intake design to minimize the ingestion of airborne particulate material over the entire time period that emergency power is required. The reviewer also verifies the following:
 - a. That the intake design is reviewed to assure that the bottom of the intake opening is located a minimum of 20 feet above grade.
 - b. That the SAR is reviewed to assure that provisions have been made to minimize the generation of dust, particularly in multiunit plants when one unit is operating and the other is under construction (abnormal generation of dust).

Dust control in the diesel generator rooms entering via the ventilation system is reviewed by ASB as part of its review responsibility for SRP

Section 9.4.5. In SRP Section 8.3.1, PSB reviews the SAR to assure that the electrical equipment associated with starting the diesel generators (e.g., auxiliary relay contacts, control switches, individually or panel mounted) are protected from dust accumulation, other deleterious material entering diesel generator room, and dust generated from concrete floors and walls.

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 emergency diesel generator combustion air intake and exhaust system (EDECAIES) includes all components and piping of the air intake system from the atmospheric air intake to its connection to the engine interface and all components and piping of the exhaust system from its connection to the engine interface to the point where it exhausts to the atmosphere. The scope of the review of the EDECAIES for the _____ plant included layout drawings, piping and instrumentation diagrams, and descriptive information for the system and auxiliary supporting systems that are essential to its safe operation. The essential portions of the EDECAIES that are necessary for the safe shutdown of the reactor or necessary to mitigate the consequences of an accident are designed to seismic Category I and Quality Group C.

The staff concludes that the design of the emergency diesel generator combustion air intake and exhaust system is acceptable and meets the requirements of GDC 2, 4, 5, and 17. This conclusion is based on the following:

1. The applicant has met the requirements of GDC 2, "Design Bases for Protection Against Natural Phenomena," with respect to the ability of structures housing the EDECAIES and the system itself to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, and GDC 4, "Environmental and Missile Design Bases," with respect to structures housing the system and the system itself being capable of withstanding the effects of externally and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks. The EDECAIES is housed in a seismic Category I structure which provides protection from the effects of tornadoes, tornado missiles, turbine missiles, and floods. The exposed portions of the system are also protected from tornadoes, tornado missiles, turbine missiles, and floods. This meets the positions of Regulatory Guides 1.115, "Protection Against Low-Trajectory Turbine Missiles," Position C.1 and 1.117, "Tornado Design Classification," Appendix Position 13.
2. The applicant has met the requirements of GDC 5, "Sharing of Structures, Systems and Components," with respect to the capability of shared systems and components important to safety to perform required safety functions. Each unit of the _____ plant has its own emergency diesel generators, whose EDECAIES is not shared between the diesel generators.

3. The applicant has met the requirements of GDC 17, "Electric Power Systems," with respect to the capability of combustion air intake and exhaust system to meet independence and redundancy criteria. Each EDECAIES is independent and physically separated from the other system serving the redundant diesel generators. Single failure in any one of the two systems will affect only the associated diesel generator. Each system is sized and physically arranged such that no degradation of engine function will be experienced when the diesel generator set is required to operate continuously at maximum rated power output. The air intakes are located _____ feet above plant grade and adequate filters are provided to minimize airborne particulate material (dust) from entering the system. Suitable design precautions have been taken to preclude degradation of the diesel engine power output due to recirculation of exhaust gases and ingestion of other dilutents that would reduce the oxygen content below acceptable levels. This meets the position of Regulatory Guide 1.9, "Selection, Design, and Qualification of Diesel Generator Units Used as Standby (Onsite) Electric Power Systems at Nuclear Power Plants." The applicant has also met the positions of Branch Technical Position ICSB-17 (PSB), "Diesel Generator Protective Trip Circuit Bypasses," and NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability." The applicant has met the requirements of the following industry standards: IEEE Standard 387, "IEEE Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations," and Diesel Engine Manufacturers Associated (DEMA) Standard.

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 schedule for the new position in Section III, item 8a, above, shall be applied 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. Regulatory Guide 1.9 "Selection, Design, and Qualification of Diesel Generator Units Used as Standby (Onsite) Electric Power Systems at Nuclear Power Plants."
6. Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Reactor Power Plants."
7. Regulatory Guide 1.115, "Protection Against Low-Trajectory Turbine Missiles."
8. Regulatory Guide 1.117, "Tornado Design Classification."
9. Branch Technical Position ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1.
10. Branch Technical Position MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.
11. Branch Technical Position ICSB-17 (PSB), "Diesel-Generator Protective Trip Circuit Bypasses" attached to SRP Section 8.3.2 Appendix 8A.
12. IEEE Standard 387, "IEEE Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations."
13. Diesel Engine Manufacturers Association (DEMA) Standard.
14. NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability."