U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

9.5.4 EMERGENCY DIESEL ENGINE FUEL OIL STORAGE AND TRANSFER SYSTEM

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - None

I. AREAS OF REVIEW

Nuclear power plants are required to have redundant onsite emergency power sources of sufficient capacity to power safety-related equipment. In almost all cases, the onsite power sources include diesel engine-driven generator sets. SRP Sections 9.5.4 through 9.5.8 cover the review of various essential elements of the emergency diesel engine sets. This SRP Section 9.5.4 deals with the fuel oil storage and transfer system for these diesel engines up to the engine housing.

The PSB review of the emergency diesel engine fuel oil storage and transfer system (EDEFSS) is performed to assure conformance with the requirements of General Design Criteria 2, 4, 5, and 17 and includes all piping up to the connection to the engine interface,[1] the fuel oil storage tanks, the fuel oil transfer pumps, day tanks, and the tank storage vaults. In addition, the review includes the quality and the quantity of fuel oil stored onsite, and the availability and procurement of additional fuel from offsite sources.

1. The diesel engine fuel oil storage and transfer system is reviewed to determine that:

   a. The system meets appropriate seismic design requirements.

   b. The system will be designed, fabricated, erected, and tested to acceptable quality standards.

[1]As defined by the engine manufacturer.

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

c. Sufficient space has been provided to permit inspection, cleaning, maintenance, and repair of the system.

d. A minimum of seven days' supply of fuel oil, for each redundant diesel generator system, has been provided onsite to meet the engineered safety feature load requirements following a loss of offsite power and a design basis accident.

e. Adequate and acceptable sources of fuel oil are available, including the means of transporting and recharging the fuel storage tank, following a design basis accident (DBA) so as to enable each redundant diesel generator system to supply uninterrupted emergency power for as long as may be required.

f. Seismic Category I structures housing the system protect it from natural phenomena and external missiles.

2. The PSB verifies that suitable precautions will be taken to prevent deleterious material from degrading the stored fuel and that periodic tests will be performed to verify that fuel degradation does not proceed to the point where engine performance is affected.

3. The PSB will determine the adequacy of the design, installation, inspection, and testing of all electrical components required for reliable operation of the system, including interlocks.

In the review of the diesel engine fuel oil storage and transfer system, the PSB will coordinate other branch evaluations that interface with the overall review of the system as follows: Structural Engineering Branch (SEB) determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of facility structures housing the system 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) reviews the seismic design qualification of components and determines that 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 EDEFSS is in accordance with Branch Technical Positions 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. The Materials Engineering Branch (MTEB) verifies upon request of PSB 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 diesel engine fuel oil storage and transfer system, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria, regulatory guides and industry standards. The review will also utilize information obtained from other Federal agencies and reports, industry standards, military specifications, available technical literature, and operational performance data obtained from similarly designed systems at other plants having satisfactory operational experience.

The design of the diesel engine fuel oil storage and transfer system 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 the system itself to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3 of the SAR, and the position of Regulatory Guide 1.117, as related to the protection of structures, systems, and components important to safety from the effects of tornado missiles, Appendix Position 13.

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, and the position of Regulatory Guide 1.115, as related to the protection of structures, systems and components important to safety from the effects of turbine missiles, Position C.1.

3. General Design Criterion 5, as related to the capability of shared systems and components important to safety to perform required safety functions.

4. General Design Criterion 17, as related to the capability of the fuel oil system to meet independence and redundancy criteria, and the guidance and positions of the following:

   a. Regulatory Guide 1.9 as related to the design of the diesel engine fuel oil systems,

   b. Regulatory Guide 1.137 as related to the diesel engine fuel oil system design, fuel oil quality and tests.

   c. Branch Technical Position ICSB-17 (PSB) as related to diesel engine fuel oil systems' protective interlocks during accident conditions.

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

   e. IEEE Standard 387 as related to the design of the diesel engine fuel oil system.

f. ANSI Standard N195, "Fuel Oil Systems for Standby Diesel Generators."

g. Diesel Engine Manufacturers' Association (DEMA) Standard as related to the design of the diesel fuel oil system.

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 meet the acceptance criteria given in subsection II of this SRP section. For the review of operating license (OL) applications, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design. The OL review includes verification that the content and intent of the technical specifications prepared by the applicant are in agreement with 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.

Plant-to-plant variations in the design of fuel oil storage and transfer systems will occur due to the number of architect-engineering companies having design responsibility in this area. Differences may occur in the number of redundant systems, in piping interconnections between diesel engines, and in sharing requirements between units. The reviewer will select and emphasize material from the paragraphs below to fit the particular design under review.

The primary reviewer will coordinate this review with other branches for their particular areas of responsibility as stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

1. The SAR is reviewed to verify that the diesel engine fuel oil storage and transfer system description and related diagrams clearly indicate all modes of system operation, including the means for indicating, controlling, and monitoring fuel oil level, temperature, and pressure as required for uninterrupted operation.

2. The reviewer verifies that the system is designed to withstand the effects of seismic events, other design bases, natural phenomena, and internally and externally generated missiles. The review of internally generated missiles will consider the relative locations and orientation of components as placed in the facility.

3. Piping and interconnections between systems are reviewed to verify that single active failures will not cause unacceptable results. The associated drawings are examined to ascertain that sufficient space has been provided around the components to permit inspection, cleaning, maintenance, and repair.

4. 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 EDEFSS including the isolation valves separating essential and nonessential portions 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 group classifications have been included and that the P&IDs indicate any points of change at the systems and/or systems components interfaces.

5. The reviewer verifies that the design is such as to minimize the creation of turbulence of the sediment at the bottom of the fuel oil storage tank or the chance of deleterious material entering the system during recharging, or by operator error, or due to natural phenomena. The reviewer will ascertain that provisions or a program have been incorporated to assure that the quality of the stored fuel oil meets minimum requirements at all times.

6. The descriptive information and drawings in the SAR are reviewed to verify that:

   a. Each storage tank is equipped with an outside fill and vent line, located and protected so as to minimize the chance of damage, from vehicles, tornado, tornado missiles, and floods. The fill and vent point should be located higher than the PMF flood level. Each tank is also provided with a stick gauge connection for determining fuel level in the tank.

   b. The minimum onsite inventory of fuel oil for each redundant diesel-generator system is sufficient to enable the diesel generators to power required engineered safety features for a period of seven days following any design basis accident and loss of offsite power.

   c. The physical location of the day tank associated with each diesel-generator set is located at an elevation to assure a slight positive pressure at the engine-driven fuel oil pump(s). Where this requirement is contrary to manufacturers' recommendation, justification and a detailed system description shall be provided in the SAR. Additionally, the justification for locating the day tank other than stated above shall assure that the diesel-generator unit can start automatically and attain the required voltage and frequency within acceptable limits and time. If a booster pump is required, it shall be powered from a reliable power supply and arranged to operate when the engine receives a start signal and it shall operate during the engine starting cycle or until system fuel oil pressure is established by the engine-driven fuel oil pump.

   d. A day or integral tank overflow line is provided to return excess fuel oil delivered by the transfer pump back to the fuel oil storage tank.

   e. A low-level alarm is provided to enable the operator to accomplish minor repairs or maintenance before all fuel in the day or integral tank is consumed (assuming full-power operation).

   f. The day or integral tank and storage tanks associated with each diesel-generator set include provisions for removal of accumulated water.

7. The reviewer verifies that suitable precautions will be taken, once the fuel oil tank has been filled, to exclude sources of ignition such as open flames or hot surfaces, and that protective measures such as compartmentation of redundant elements are used to minimize the potential causes and consequences of fires and explosions.

8. The reviewer verifies that the system function will be maintained as required in the event of failure of nonseismic Category I systems or structures located near the system. Reference to the SAR sections describing site features and the general arrangement and layout drawings will be necessary in this determination. Plant arrangement features, in conjunction with the protection obtained by location and the design of the system and structures, are considered in determining the ability of the system to maintain function in the event of such failures.

9. The diesel engine fuel oil storage and transfer system is reviewed to verify that protection from the effects of breaks in high and moderate energy lines has been provided. Layout drawings are reviewed to assure that no high- or moderate-energy piping systems are located close to the fuel oil 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 the procedures for reviewing this information by ASB are given in the corresponding SRP sections.

10. The descriptive information, related system drawings, and the results of failure modes and effects analyses in the SAR are reviewed to verify that minimum system requirements will be met following design basis accidents assuming a concurrent single active component failure. 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 emergency diesel engine fuel oil storage and transfer system (EDEFSS) includes storage tanks, fill, vent, stick gauge drain, and overflow return lines, fuel oil transfer pumps, strainers, filters, valves, day tanks, and all components and piping up to the connections to the engine interfaces. The scope of review of the diesel engine fuel oil storage and transfer system for the _____ plant included layout drawings, piping and instrumentation diagrams, and descriptive information for the system and auxiliary supporting systems essential to its operation. The essential portions of the EDFESS 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 basis for acceptance of the EDEFSS in our review was conformance of the design criteria and bases to the Commission's regulations as set forth in the General Design Criteria (GDC) of Appendix A to 10 CFR Part 50. The staff concludes that the plant design 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 EDEFSS 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 EDEFSS, except for the buried fuel oil storage tanks and related components and piping, is housed in a Seismic Category I structure which provides protection from the effects of tornados, tornado missiles, turbine missiles, and floods. The buried portions are also protected from tornados, tornado and turbine missiles, and floods. This meets the positions of Regulatory Guide 1.115, "Protection Against Low-Trajectory Turbine Missiles," Position C.1, and "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 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 EDEFSS 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 the fuel oil system to meet independence and redundancy criteria. Each EDEFSS is independent and physically separated from the other system serving the redundant diesel generator. A single failure in any one of the two systems will affect only the associated diesel generator. This meets the positions of Regulatory Guide 1.9, "Selection, Design, and Qualification of Diesel Generator Units Used As Standby (Onsite) Electric Power Systems At Nuclear Power Plants," and Regulatory Guide 1.137, "Diesel Generator Fuel Oil Systems." 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: ANSI-N195 "Fuel Oil Systems for Standby Diesel Generators," IEEE-Standard 387 "IEEE Standard Criteria For Diesel Generator Units Applied As Standby Power Supplies For Nuclear Power Goverating Stations," and Diesel Engine Manufacturers Association (DEMA) Standard.

The staff concludes that the design of the diesel fuel oil storage and transfer system conforms to all applicable GDC, positions of the regulatory guides cited, NUREG/CR-0660, staff positions, and industry standards, and is therefore acceptable.

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.

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 1.115, "Protection Against Low-Trajectory Turbine Missiles."

7. Regulatory Guide 1.117, "Tornado Design Classification."

8. Regulatory Guide 1.137, "Diesel Generator Fuel Oil Systems."

9. ANSI Standard N195, "Fuel Oil Systems for Standby Diesel Generators," American National Standards Institute.

10. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment" (attached to SRP Section 3.6.1).

11. Branch Technical Position MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment" (attached to SRP Section 3.6.2).

12. Branch Technical Position ASB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants" (attached to SRP Section 9.5.1).

13. Branch Technical Position ICSB-17 (PSB), "Diesel-Generator Protective Trip Circuit Bypasses" (attached to SRP 8.3.2, Appendix 8A).

14. IEEE Standard 387 "IEEE Standard Criteria for Diesel Generator Units Applied As Standby Power Supplies for Nuclear Power Generating Stations."

15. Diesel Engine Manufacturers Association (DEMA) Standard.

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