

# Interim Use and Comment

U.S. NUCLEAR REGULATORY COMMISSION

## DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER™ iPWR DESIGN

### 9.5.4 EMERGENCY DIESEL ENGINE FUEL OIL STORAGE AND TRANSFER SYSTEM

#### REVIEW RESPONSIBILITIES

**Primary** - Organization responsible for the review of diesel generator support systems

**Secondary** - Organization responsible for the review of fuel oil quality and testing

#### I. AREA OF REVIEW

Nuclear power plants are required to have redundant onsite emergency power sources of sufficient capacity to permit functioning of structures, systems and components (SSC) important to safety. In almost all cases, the onsite power sources include diesel-engine-driven generator sets. The emergency diesel engine (EDE) fuel oil storage and transfer system (EDEFSS) performs the safety function of storing quality fuel on site and transferring it to the EDE following an engine start signal to support the emergency diesel generator in performing its safety function for the required period of operation. Design Specific Review Standard (DSRS) Sections 9.5.4 through 9.5.8 cover the review of various essential elements of emergency diesel generator support systems

This DSRS section covers the fuel oil storage and transfer system for EDEs up to the system interface with the engine-mounted components of the fuel oil system as defined by the engine manufacturer. The system components mounted directly on the diesel engine and its support structure are reviewed with the engine generator in accordance with DSRS Section 8.3.1, “AC Power Systems (Onsite).”

The review of the EDEFSS assures compliance with the requirements of General Design Criteria (GDCs) 1, 2, 4, 5, and 17 by all piping up to the connection to the engine interface; the fuel oil storage tanks; the fuel oil transfer pumps; the day tanks; and the tank storage vaults, where applicable. In addition, the review assures that adequate quality and quantity of fuel oil is stored onsite; that fuel from offsite sources is available for replenishment of the onsite storage for long-term operation; that the system is protected from corrosion; and that the materials of construction for system components are compatible with the fuel oil.

Depending on the design and regulatory treatment of nonsafety-related system (RTNSS) analysis, the fuel oil system for a passive plant design may be classified as:

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- (1) Safety-related risk-significant
- (2) Safety-related nonrisk significant
- (3) Nonsafety-related risk-significant, which includes RTNSS B and RTNSS C
- (4) Nonsafety-related nonrisk-significant

The mPower™ application will include the classification of SSCs, a list of risk-significant SSCs, and a list of RTNSS equipment. Based on this information, the staff will review according to DSRs Section 3.2, SRP Sections 17.4 and 19.3 to confirm the determination of the safety-related and risk-significant SSCs.

The current passive plant designs (AP1000, ESBWR, and mPower™) may include the following nonsafety-related risk-significant onsite AC power supplies:

- A. Ancillary Diesel Generators – classified as RTNSS Criterion B and designed for seismic events and other natural phenomena.
- B. Standby Diesel Generators – classified as RTNSS Criterion C

For these designs, the fuel oil system for the onsite power supply driver may be subject to RTNSS considerations.

The specific areas of review for the safety-related EDEFSS are as listed below. All of the areas of review listed below apply to fuel oil systems classified as RTNSS Criterion B or Criterion C (RTNSS B and C), as described above, unless otherwise indicated. The RTNSS-specific review guidance, where different from that of a safety-related EDEFSS, will be presented in italics throughout this DSRs section. For nonsafety-related nonrisk-significant fuel oil systems, no requirements other than those specifically identified in italics below apply.

For this area of review, the reviewer must evaluate the following:

- 1. Appropriate safety/risk significant classification as discussed above.
- 2. Compliance with the requirements of GDCs 1, 2, 4, 5, and 17.

*RTNSS B and C: Standard Review Plan (SRP) Section 19.3 defines the applicability of the GDCs to RTNSS SSCs.*

- 3. The capability of the EDEFSS to adequately store and transfer fuel oil to the EDE for all planned operating conditions for the required duration.
- 4. The functional performance requirements of the system, including the ability to withstand design-basis adverse operational and environmental occurrences, operability requirements for normal operation, and requirements for operation during and following postulated accidents.
- 5. Design, fabrication, erection and testing to appropriate codes and standards.

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6. Appropriate design classification of structures housing portions of the system important to safety.
7. Consequences of a single active failure.
8. The effects of non-Seismic Category I component failures on the Seismic Category I portion of the system.

*RTNSS B: SSCs required to function following a seismic event should be reviewed for the effects of non-Seismic Category I component failures.*

9. The provisions for detection, collection, and control of system leakage.
10. Appropriate boundary divisions between safety-related and nonsafety-related portions of the system.
11. The requirements for operational testing and inservice inspection of the system.

*RTNSS B and C: does not directly apply. RTNSS B and C: does not apply directly since RTNSS B SSCs are considered risk-significant and RTNSS C SSCs support cold shutdown conditions. Testing and inservice inspection are elements of the reliability assurance program (RAP). Also, surveillance testing is done for items in the Availability Controls Manual. Alternative criteria are addressed in DSRS Section 19.3 on the programmatic requirements for RTNSS with respect to inspection and testing.*

12. Instrumentation and control features necessary to accomplish design functions, including isolation of components for leakage or malfunctions and actuation requirements for redundant equipment.
13. Space provided to permit inspection, cleaning, maintenance, and repair of the system.
14. Availability of sources of fuel oil, including the means of transporting and recharging the fuel storage tank to enable each redundant diesel generator system to supply uninterrupted power for as long as required to meet the plant design bases.
15. Monitoring program to verify an acceptable level of fuel quality upon delivery and during extended storage of the fuel.
16. Corrosion protection design (including material compatibility), installation and testing to ensure that over the life of the plant, corrosion of system components will not prevent the system from performing required functions.
17. The provisions for prevention, detection and suppression of fire.

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18. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this DSRS section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this DSRS section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.
19. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information items in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

## Review Interfaces

Other DSRS or SRP sections interface with this section for safety-related and nonsafety-related EDEFSS, as follows. The need for each of the following interface reviews for a RTNSS B and C fuel oil system should be based on the RTNSS B and C review guidance and acceptance criteria for the system included in this section and in SRP Section 19.3.

1. DSRS Sections 3.2.1 and 3.2.2: review of the acceptability of seismic and quality group classifications for EDEFSS components.
2. DSRS sections 3.3.1, 3.3.2, 3.5.3, 3.7.2 and SRP sections 3.7.1, 3.7.3, 3.7.4, 3.8.4, and 3.8.5: review of the acceptability of the design analyses, procedures, and criteria establishing the capability of Seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena like the safe shutdown earthquake, probable maximum flood, and tornado missiles.

*RTNSS B: corresponding review of structures that house system components that must perform their function following a seismic event.*

3. DSRS section 3.4.1: review for flood protection.
4. DSRS section 3.5.1.1: review of protection against internally-generated missiles.
5. DSRS sections 3.5.1.4 and 3.5.2: review of SSC protection against the effects of externally-generated missiles.
6. SRP section 3.6.1: review of high-energy and moderate-energy pipe breaks.

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7. DSRS sections 3.9.1 and 3.9.2 and SRP Section 3.9.3: review of EDEFSS SSCs for whether they are in accordance with the applicable codes and standards.
8. DSRS section 3.9.6: review of the adequacy of the inservice testing program for pumps and valves.
9. DSRS section 6.6: review to verify whether system components meet inservice inspection requirements and the compatibility of the materials of construction with service conditions.
10. DSRS Chapter 7: review to determine the adequacy of the design, installation, inspection, and testing of all essential EDEFSS controls and instrumentation.
11. DSRS section 8.1: review to determine the adequacy of the design, installation, inspection, and testing of all essential electrical components required for proper operation.
12. DSRS section 8.3.1: review of the adequacy of the design, installation, inspection, and testing of the diesel generator and all electrical components (sensing, control, and power) required for proper EDEFSS operation including interlocks.
13. DSRS section 8.4: overall review of compliance with station blackout requirements.
14. SRP section 9.5.1: review for fire protection requirements.
15. DSRS sections 14.2 and 14.3.7: review for initial plant testing and plant systems ITAAC.
16. DSRS section 16.0: review of technical specifications.
17. SRP section 17.5: review of quality assurance requirements.SRP
18. SRP section 19.3: review for probabilistic risk assessment, for the applicable risk classification, and for the application of regulatory requirements to RTNSS SSCs.

The specific acceptance criteria and review procedures are contained in the referenced DSRS sections.

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## II. ACCEPTANCE CRITERIA

### Requirements

Acceptance criteria for a safety-related EDEFSS are based on meeting the relevant requirements of the following Commission regulations. The RTNSS-specific acceptance criteria for nonsafety-related risk-significant SSCs, including the application of GDCs, are addressed in SRP Section 19.3. System-specific acceptance criteria are addressed in this DSRS Section 9.5.4. For a nonsafety-related nonrisk-significant fuel oil system, nothing applies unless noted below in italics..

1. GDC 1, "Quality Standards and Records," as it relates to quality standards commensurate with the importance of the safety functions to be performed.
2. GDC 2, "Design Bases for Protection Against Natural Phenomena," as it relates to capability of SSCs important to safety to withstand the effects of natural phenomena such as earthquakes, tornadoes, tsunamis, hurricanes, floods, tsunamis and seiches, without loss of capability to perform their safety function.
3. GDC 4, "Environmental and Dynamic Effects Design Bases," as it relates to capability of SSCs important to safety to withstand environmental conditions and dynamic effects of externally-generated and internally-generated missiles, pipe whip, and jet impingement forces of pipe breaks, during normal plant operation as well as during maintenance, testing, and postulated accident conditions.
4. GDC 5, "Sharing of Structures, Systems, and Components," which provides that SSCs important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.
5. GDC 17, "Electric Power Systems," as it relates to the capability of the EDEFSS to support the capability of the onsite emergency power system to perform its safety functions assuming a single failure, including the requirements for independence, redundancy, and testability.
6. 10 CFR 52.47(b)(1), which requires that a design certification (DC) application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the Atomic Energy Act, and the NRC's rules and regulations.

*RTNSS B and C this section applies using the guidance in DSRS Section 14.3.7, but moderated based on risk importance and the level of confidence that the design requirement will be met (e.g., a new and unique component design may warrant an ITAAC for an important function to confirm that the design requirement can be met). ITAAC are not necessarily required for RTNSS SSCs (see SRP section 19.3).*

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7. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's rules and regulations.

*RTNSS B and C: this section applies using the guidance in DSRS Section 14.3.7, but moderated based on risk importance and the level of confidence that the design requirement will be met. ITAAC are not necessarily required for RTNSS SSCs.*

## DSRS Acceptance Criteria

Specific DSRS acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are set forth below. The DSRS is not a substitute for the NRC's regulations, and compliance with it is not required. Identifying the differences between this DSRS section and the design features, analytical techniques, and procedural measures proposed for the facility, and discussing how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria, is sufficient to meet the requirements in 10 CFR 52.47(a)(9), "Contents of applications; technical information." The same approach may be used to meet the requirements of 10 CFR 52.79(a)(41) for COL applications.

The acceptance criteria listed below apply to fuel oil systems classified as safety-related, RTNSS Criterion B, or RTNSS Criterion C, unless otherwise indicated. The RTNSS-specific acceptance criteria, where different from that of a safety-related EDEFSS, are presented in italics. For a nonsafety-related nonrisk-significant fuel oil system, nothing applies unless noted below in italics.

1. Quality standards and records. Information that addresses the requirements of GDC 1 regarding the quality standards and records for SSCs important to safety will be considered acceptable if the guidance of Regulatory Guide (RG) 1.28, "Quality Assurance Program Criteria (Design and Construction)," are appropriately addressed. A quality assurance (QA) program shall be established and implemented. Appropriate records of the design, fabrication, erection, and testing of SSCs important to safety shall be maintained.

*RTNSS B and C: does not apply. The QA program, including documentation requirements, for RTNSS SSCs should be the manufacturer's standard program for nonnuclear safety SSCs.*

2. Protection against natural phenomena. Information that addresses the requirements of GDC 2 regarding the capability of structures housing the EDEFSS to withstand the effects of natural phenomena will be considered acceptable if the guidance of RG 1.29, Position C.1 for safety-related portions of the EDEFSS and Position C.2 for nonsafety-related portions of the EDEFSS are appropriately addressed. Comprehensive

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compliance with GDC 2 is reviewed under other DSRS sections as specified in Subsection I of this DSRS section.

*RTNSS B and C SSCs: applies to the effects of natural phenomena without loss of function, using a graded approach. SRP Section 19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.*

3. Environmental and dynamic effects. Comprehensive compliance with GDC 4 is reviewed under other DSRS sections as specified in Subsection I of this DSRS section.
4. Sharing of structures, systems, and components. If the EDEFSS is shared by multiple nuclear units at a facility, the applicant must demonstrate that such sharing meets the requirements of GDC 5 regarding the capability of shared systems and components important to safety to perform their required safety functions, including, in the event of an accident at one unit, a safe and orderly shutdown and cool-down in the remaining unit(s).
5. Independence, redundancy and testability. Information that addresses the requirements of GDC 17 regarding the capability of the EDEFSS to meet independence, redundancy and testability criteria will be considered acceptable if the guidance of RG 1.137, "Fuel Oil Systems for Emergency Power Supplies," are appropriately addressed and the NRC recommendations specified in NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability," are implemented, where applicable.

*RTNSS B/C and nonsafety-related nonrisk-significant : The guidance in RG 1.137 that reflects good engineering and maintenance practices for industrial applications, including applicable ASTM Standards, is considered appropriate acceptance criteria. Special design requirements for nuclear power plants, such as compliance with ASME Section III, are not required for acceptance of a RTNSS B and C and nonsafety-related nonrisk-significant fuel oil system. A dedicated fuel oil transfer system should be provided for each RTNSS B and C diesel generator (or for each engine-generator set if multiple engine-generators provide the power requirements for a single electrical power supply train).*

*A single fuel oil storage tank may be acceptable for multiple diesel generators if the tank is appropriately protected against natural/environmental hazards as addressed above for GDC 2. The RG 1.137 guidance for the quantity of fuel stored on site is also applicable to RTNSS B and C fuel oil systems. The calculation of the quantity of fuel oil stored on site to ensure 7 days of operation without fuel delivery may consider the reduced or nonexistent fuel oil consumption during the first 72 hours following the DBA. However, the fuel oil consumed by any expected or desirable operation of the diesels, whether as the primary or as the backup power supply, must not impinge on the capability to perform the required post DBA plus 72 hour system functions for at least 4 days<sup>1</sup>.*

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<sup>1</sup> See SRP Section 19.3 for post DBA and beyond 72 hour requirements.  
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*In addition, the acceptance should be based on the correlation between the associated risk and the supporting design for independence, redundancy, testability and single active failure.*

## III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

These review procedures are based on the identified DSRS acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

Upon request from the primary reviewer, the secondary reviewers provide input for the areas of review in Subsection I of this DSRS section. The primary reviewer uses such input as required to complete this review procedure. For aspects of the EDEFSS design that must comply with regulatory requirements that are also applicable to other systems (e.g., ASME Section III, seismic design, ITAAC, and RTNSS),

Plant-to-plant variations in the design of the EDEFSS can occur due to multiple architect-engineering companies and engine-generator manufacturers having design responsibility in this area. Differences may occur such as the fuel oil storage arrangement, piping configurations and component redundancy. The reviewer selects and emphasizes material from the following paragraphs and supplements that material as required to fit the particular design under review. The applicability of review procedures for RTNSS B and C fuel oil systems is described in italics. For nonsafety-related nonrisk-significant fuel oil systems, no requirements other than those specifically identified below in italics apply. Additional review guidance for RTNSS SSCs is provided in SRP Section 19.3.

1. Programmatic Requirements - In accordance with the guidance in NUREG – 0800 “*Introduction*,” Part 2 as applied to this DSRS Section, the staff will review the programs proposed by the applicant to satisfy the following programmatic requirements. If any of the proposed programs satisfies the acceptance criteria described in Subsection II, it can be used to augment or replace some of the review procedures. It should be noted that the wording of “to augment or replace” applies to nonsafety-related risk-significant SSCs, but “to replace” applies to nonsafety-related nonrisk-significant SSCs according to the “graded approach” discussion in NUREG-0800 “*Introduction*,” Part 2. Commission regulations and policy mandate programs applicable to SSCs that include:
  - A. Maintenance Rule SRP Section 17.6 (DSRS Section 13.4, Table 13.4, Item 17, Regulatory Guides 1.160, “Monitoring the Effectiveness of Maintenance at Nuclear Power Plants.” and RG 1.182; “Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants”.
  - B. Quality Assurance Program SRP Sections 17.3 and 17.5 (DSRS Section 13.4, Table 13.4, Item 16).
  - C. Technical Specifications (DSRS Section 16.0 and SRP Section 16.1) – including brackets value for DC and COL. Brackets are used to identify information or

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characteristics that are plant specific or are based on preliminary design information.

- D. Reliability Assurance Program (SRP Section 17.4).
- E. Initial Plant Test Program (Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants," DSRs Section 14.2, and DSRs Section 13.4, Table 13.4, Item 19).
- F. ITAAC (DSRS Chapter 14).

*RTNSS B and C: applies; however, Technical Specifications may not apply and are replaced with Short Term Availability Controls, as required. RG 1.215 only applies if ITAAC are required.*

2. For new reactor license applications submitted under Part 52, the applicant is required to (1) address the proposed technical resolution of unresolved safety issues (USIs) and medium- and high-priority generic safety issues (GSIs) that are identified in the version of NUREG-0933 current on the date 6 months before application and that are technically relevant to the design; (2) demonstrate how the operating experience insights have been incorporated into the plant design; and, (3) provide information necessary to demonstrate compliance with any technically relevant portions of the Three Mile Island requirements set forth in 10 CFR 50.34(f), except paragraphs (f)(1)(xii), (f)(2)(ix), and (f)(3)(v). Reference: 10 CFR 52.47(a)(21), 10 CFR 52.47(a)(22), and 10 CFR 52.47(a)(8), respectively. These cross-cutting review areas should be addressed by the reviewer for each technical subsection and relevant conclusions documented in the corresponding SER section.
3. The reviewer reviews the applicant's final safety analysis report (FSAR) to verify whether the EDEFSS description and related diagrams clearly indicate the system functions for all modes of system operation, including the means for indicating, controlling, and monitoring fuel oil level, temperature, and pressure, as required for uninterrupted operation.

*RTNSS B and C: applies.*

4. The reviewer verifies whether essential portions of the system are protected from the effects of high-energy and moderate-energy line breaks. The system description and layout drawings are reviewed (if available) for whether no high-energy or moderate-energy piping systems are close to essential EDEFSS portions, or for protection from the effects of failure. The means for such protection are in FSAR Section 3.6, and the procedures for reviewing this information are in the corresponding DSRs sections.

*RTNSS B and C: applies.*

5. The FSAR descriptive information, related system drawings, and results of failure modes and effects analyses are reviewed to verify whether minimum system requirements will be met following DBAs, assuming a concurrent single active component failure. For each case the design is acceptable if minimum system requirements defined in this DSRs section are met.

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*RTNSS B and C: applies, however failure modes and effects analyses are not performed.*

6. The seismic design bases and the seismic and quality group classifications are reviewed by interfacing reviewers as indicated in Subsection I of this DSRS section. The primary reviewer verifies whether essential EDEFSS portions including the isolation valves separating essential and nonessential portions are classified Quality Group C and Seismic Category I. SAR component and system descriptions of mechanical and performance characteristics are reviewed to verify whether the appropriate seismic and quality group classifications are specified and whether the piping and instrumentation drawings correctly indicate any points of change at the system or system component interfaces.

*RTNSS B and C: applies as appropriate to the quality group and seismic classification of the SSCs, as determined by the guidance in SRP Section 19.3.*

7. The reviewer verifies whether the design minimizes turbulence of the sediment at the bottom of the fuel oil storage tank or any chance of deleterious material entering the system during recharging, by operator error, or due to natural phenomena.

*RTNSS B and C: applies.*

8. The FSAR descriptive information and drawings are reviewed to verify whether (each of the following applies to RTNSS B and C SSCs, unless noted otherwise):

- A. Each storage tank is equipped with one or more outside fill and vent lines located and protected to minimize any chance of damage from vehicles, tornado, tornado missiles, and floods. The fill and vent point should be located higher than the probable maximum flood level. Each underground direct-buried tank also has a stick gauge connection for determining its fuel level. Two diverse and independent means of monitoring tank level should be provided, with local and main control room indication, for all storage tanks. An alarm should warn the operator that the fuel inventory is below the seven-day quantity.

*RTNSS B and C: applies, except that the design for protection for flooding, high winds, and wind related missiles should be based on the criteria in SRP Section 19.3. A RTNSS B fuel oil system should be available to perform the risk important functions following the seismic event and design-basis hurricane, but need not perform these functions during the seismic event or hurricane.*

- B. The minimum onsite inventory of fuel oil for each diesel generator system is sufficient to enable the diesel generators to power required engineered safety features for a period of seven days or longer following any DBA and loss of offsite power as specified by ANSI/ANS-59.51 and in accordance with the guidance in RG 1.137.

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*RTNSS B AND C: applies for the design basis operation of the system, including electrical load and duration of operation. For post-72 hour functions, the seven-day storage capacity may be based on operation for 4 days of design load operation beginning 72 hours after the DBA, with adequate additional storage capacity for any expected or desirable operation during the 72 hours following the DBA.*

- C. The physical location of the day tank for each diesel generator set is at an elevation that provides the net positive suction head (NPSH) required at the inlet to the engine-driven fuel oil pump(s). Where the provided NPSH is contrary to manufacturer's recommendations, the FSAR must provide justification and a detailed system description. Additionally, justification for locating the day tank otherwise must confirm that the diesel generator unit can start automatically and attain the required voltage and frequency within an acceptable time. Any required booster pump must be powered from the Class 1E power supply for the associated diesel generator set, operate when the engine receives a start signal, and operate during the engine starting cycle or until system fuel oil pressure is established by the engine-driven fuel oil pump, as needed to provide a continuous supply of fuel oil to the engine.

*RTNSS B and C: applies with regard to the location of the day tank.*

- D. A day or integral tank overflow line returns excess fuel oil delivered by the transfer pump back to the fuel oil storage tank.
  - E. A low-level alarm enables 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 for each diesel generator set include provisions for removal of accumulated water.
  - G. The space around the components is sufficient to permit inspection, cleaning, maintenance, and repair.
9. The reviewer verifies whether suitable precautions will be taken, after the fuel oil tank has been filled, to exclude sources of ignition like open flames or hot surfaces and whether protective measures like compartmentalization of redundant elements minimize the potential for and consequences of fires and explosions.

*RTNSS B and C: applies.*

10. The reviewer verifies whether the system function will be maintained as required in any failure of non-Seismic Category I SSCs near the system. Plant arrangement features and the protections obtained by location and the design of the system and structures are considered in determining the ability of the system to maintain functions in such failures.

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*RTNSS B: applies to portions of the system that must function following the seismic event.*

*RTNSS C: does not apply.*

11. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meet the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

*RTNSS B and C: applies.*

12. For review of both DC and COL applications, DSRS Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of the review of the EDEFSS in accordance with this DSRS section.

*RTNSS B/C: applies using a graded review approach for ITAAC, commensurate with the risk importance of the system functions and the level of confidence that the design requirement will be met. ITAAC are not necessarily required for RTNSS SSCs.*

## IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions. The applicability of the evaluation findings to RTNSS B and RTNSS C fuel oil systems is described in italics. For nonsafety-related nonrisk-significant systems, nothing applies unless noted below.

The EDEFSS includes storage tanks with connections for oil transfer, fill, vent, stick gauge (where applicable), drain, sample, pump-out, 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 EDEFSS for the plant included layout drawings, piping and instrumentation diagrams, and descriptive information for the system and auxiliary supporting systems essential to its operation. Essential EDEFSS portions necessary for safe shutdown of the reactor or for mitigation of the consequences of an accident are designated to Seismic Category I and Quality Group C.

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*RTNSS B and C: applies. Seismic category and quality group classification are as required by SRP Section 19.3. The extent of the design information, including drawings, provided for RTNSS SSCs may be less than that provided for a safety-related EDEFSS.*

The basis for acceptance of the EDEFSS in the review was compliance of the design criteria and bases with NRC regulations as stated in the GDCs of Appendix A to 10 CFR Part 50. The staff concludes that the design is acceptable and meets the requirements of GDC 1, 2, 4, 5 and 17. This conclusion is based on the following findings *(the applicability of the GDCs and the corresponding findings that the design is acceptable and meets regulatory requirements should be in accordance with the general guidance in SRP Section 19.3 and the system-specific guidance in this DSRS Section 9.5.4)*:

1. The applicant meets the requirements of GDC 1, "Quality Standards and Records." Acceptance is based on the SSCs important to safety as being designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Recognized codes and standards are identified and the staff evaluated them to determine their applicability, adequacy, and sufficiency. Quality will be assured by keeping appropriate records of the design, fabrication, erection, and testing of SSCs important to safety. These records will be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit. The licensee quality assurance program is in accordance with the guidelines of Regulatory Guide (RG) 1.28, "Quality Assurance Program Requirements (Design and Construction)."

*RTNSS B and C: does not apply. The diesel fuel oil system should be in accordance with the manufacturers' quality assurance programs for nonsafety-related nuclear plant SSCs. Revise the above paragraph to read:*

*The applicant meets the regulatory requirements for the quality assurance program applied to the diesel fuel oil system SSCs. The system SSCs are designed, fabricated, erected, and tested to quality standards commensurate with the risk importance of the system functions. Recognized codes and standards are identified and the staff evaluated them to determine their applicability, adequacy, and sufficiency.*

2. The applicant has met the requirements of GDC 2, "Design Bases for Protection Against Natural Phenomena," for the ability of structures housing the EDEFSS and the system itself to withstand the effects of natural phenomena like earthquakes, tornadoes, hurricanes, floods, tsunamis and seiches, and GDC 4, "Environmental and Dynamic Effects Design Bases," for the ability of structures housing the system and the system itself to withstand the effects of externally- and internally-generated missiles, pipe whip, and jet impingement forces of pipe breaks. The EDEFSS is housed in a Seismic Category I structure (except for direct-buried underground fuel oil storage tanks and related components and piping, where provided) which protects against the effects of tornadoes, tornado missiles, turbine missiles, and floods. Tank vent openings are located above the design basis flood level and fill, pump-out, and sample connections are fitted with leak tight covers and locked closed valves. The buried portions of the system also are protected from tornadoes, tornado and turbine missiles, and floods. This protection meets the positions of RG 1.115, "Protection Against Low-Trajectory Turbine Missiles," Position C.1, and RG 1.117, "Tornado Design Classification," Appendix Position 13.

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*RTNSS B and C: Design for external hazards should be as required by SRP Section 19.3 and the evaluation finding should be worded accordingly.*

3. The applicant has met the requirements of GDC 5, "Sharing of Structures, Systems, and Components," for the ability of shared systems and components important to safety to perform required safety functions. Each unit of the plant has its own emergency diesel generators with EDEFSS not shared between them.

*RTNSS B and C: does not apply.*

4. The applicant has met the requirements of GDC 17, "Electric Power Systems," for the ability of the fuel oil system to meet independence, redundancy, and testability criteria. Each EDEFSS is independent and physically separated from the other system(s) serving the redundant diesel generator(s). A single failure in any one EDEFSS will affect only its diesel generator. This arrangement meets the position of RG1.137 "Diesel Generator Fuel Oil Systems." The applicant has met the other positions of RG 1.137 to ensure reliability and availability of the system. The applicant has also met the applicable positions of NUREG/CR-0660, "Enhancement Of Onsite Emergency Diesel Generator Reliability." The applicant has met the requirements for a monitoring program to verify an acceptable level of fuel quality upon delivery and during extended storage of the fuel. The applicant has met the requirements for corrosion protection design (including material compatibility), installation and testing to ensure that over the life of the plant, corrosion of system components will not prevent the system from performing required functions.

*RTNSS B and C: RG 1.137 applies to the extent that the system design ensures an appropriate level of reliability and availability, assuming a single active failure. Revise the above paragraph to read:*

*The applicant meets the guidance in RG 1.137 that reflects good engineering and maintenance practices for industrial applications, including applicable ASTM Standards. A dedicated fuel oil storage and transfer system is provided for each RTNSS B and C diesel generator (or for each engine-generator set if multiple engine-generators provide the power requirements for a single electrical power supply train). The applicant also meets the guidance in RG 1.137 for the quantity and quality of fuel stored on site and provides an acceptable design for corrosion protection of system components.*

5. The applicant has met the requirements for prevention, detection and suppression of fire hazards associated with fuel oil.

*RTNSS B and C and nonsafety-related nonrisk-significant: applies.*

The staff concludes that the EDEFSS design complies with all applicable GDCs, regulatory guide positions cited, NUREG/CR-0660 as applicable, staff positions, and industry standards and is therefore acceptable.

For DC and COL reviews, the findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this DSRS section.

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In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable.

## V. IMPLEMENTATION

The staff will use this DSRS section in performing safety evaluations of mPower™-specific design certification (DC), or combined license (COL), applications submitted by applicants pursuant to 10 CFR Part 52. The staff will use the method described herein to evaluate conformance with Commission regulations.

Because of the numerous design differences between the mPower™ and large light-water nuclear reactor power plants, and in accordance with the direction given by the Commission in SRM-COMGBJ-10-0004/COMGEA-10-0001, "Use of Risk Insights to Enhance the Safety Focus of Small Modular Reactor Reviews," dated August 31, 2010 (ML102510405), to develop risk-informed licensing review plans for each of the small modular reactor (SMR) reviews including the associated pre-application activities, the staff has developed the content of this DSRS section as an alternative method for mPower™-specific DC, or COL submitted pursuant to 10 CFR Part 52 to comply with 10 CFR 52.47(a)(9), "Contents of applications; technical information."

This regulation states, in part, that the application must contain "an evaluation of the standard plant design against the Standard Review Plan (SRP) revision in effect 6 months before the docket date of the application." The content of this DSRS section has been accepted as an alternative method for complying with 10 CFR 52.47(a)(9) as long as the mPower™ DCD FSAR does not deviate significantly from the design assumptions made by the NRC staff while preparing this DSRS section. The application must identify and describe all differences between the standard plant design and this DSRS section, and discuss how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria. If the design assumptions in the DC application deviate significantly from the DSRS, the staff will use the SRP as specified in 10 CFR 52.47(a)(9). Alternatively, the staff may supplement the DSRS section by adding appropriate criteria in order to address new design assumptions. The same approach may be used to meet the requirements of 10 CFR 52.79(a)(41), for COL applications.

## VI. REFERENCES

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."
2. 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants"
3. RG 1.28, "Quality Assurance Program Requirements (Design and Construction)."
4. RG 1.29, "Seismic Design Classification."
5. RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants."
6. RG 1.115, "Protection Against Low-Trajectory Turbine Missiles."



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7. RG 1.117, "Tornado Design Classification."
8. RG 1.137, "Diesel Generator Fuel Oil Systems."
9. RG 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants."
10. RG 1.182, "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants."
11. RG 1.215, "Guidance for ITAAC Closure Under 10 CFR Part 52."
12. NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability.," University of Dayton Research Institute; UDR-TR-79-07; February 1979.
13. ANSI/ANS-59.51-1997, "Fuel Oil Systems for Safety-Related Emergency Diesel Generators."