UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

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OCT 30 1991

MEMORANDUM FOR: Edward L. Jordan, Chairman
Committee to Review Generic Requirements

FROM: Eric Beckjord, Director
Office of Nuclear Regulatory Research

SUBJECT: CRGR REVIEW OF PROPOSED RESOLUTION OF GENERIC SAFETY ISSUE B-56, "DIESEL GENERATOR RELIABILITY"

The purpose of this memorandum is to request that the proposed resolution of Generic Safety Issue B-56 be scheduled for review by the CRGR on November 12, 1991. The Commission disapproved use of a 50.54(f) letter for resolving B-56, and directed the staff to address this safety issue through rulemaking. We have therefore prepared a Draft Commission Paper, Federal Register Notice and further revised Regulatory Guide 1.9, Revision 3, to comply with the Commission's direction provided in SRM (COMJC-91-001/001-A) dated June 26, 1991, for resolving Generic Safety Issue B-56, "Diesel Generator Reliability". These enclosures are different than previously forwarded to Mr. J. Conran and reflect Office views which have emerged over the past several weeks. Text changes are highlighted, and in particular, we bring to your attention that the sections of the Federal Register Notice dealing with Regulatory Analysis and Backfit now make use of previous station blackout findings.

If you have questions on the enclosures, please contact Al Serkiz at 492-3942.

Eric S. Beckjord, Director
Office of Nuclear Regulatory Research

Enclosures:
1. Draft Commission Paper
2. Draft Federal Register Notice
3. Draft Regulatory Guide 1.9, Rev. 3

--- PREDECISIONAL ---

DRAFT COMMISSION PAPER
RESOLUTION OF GSI B-56

For: The Commission

From: James M. Taylor
Executive Director for Operations

Subject: RESOLUTION OF GENERIC SAFETY ISSUE B-56
"DIESEL GENERATOR RELIABILITY"

Purpose: This paper is to inform the Commission of the staff's response to SRM (COMJC-91-001/001-A) dated June 26, 1991 and requests approval to issue for public comment: 1) an amended 10 CFR Part 50.63, "Station Blackout", and (2) Regulatory Guide 1.9, Revision 3 (proposed).

Background: The staff submitted to the Commission a proposed resolution for Generic Safety Issue (GSI) B-56, "Diesel Generator Reliability" on October 3, 1990 (SECY-90-340).

The Commission disapproved the use of a generic letter and the provisions of 10 CFR 50.54(f) as a vehicle for imposing requirements on, or securing enforceable commitments from power reactor licensees to address Generic Safety Issue B-56, and stated that establishment of a firm legal basis for the regulatory action (such as for this issue) should be addressed through rulemaking.

With respect to the approach to be taken in addressing the issue of emergency diesel generator (EDG) reliability, the Commission endorsed a results-oriented approach, consistent with the approach taken in the maintenance rule, that will focus on the

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overall objective of demonstrated EDG reliability in lieu of the approach recommended by the staff in SECY-90-340 and the staff was instructed to prepare for Commission approval a proposed rule and regulatory guidance which would consist of the following fundamental elements: (1) target reliability levels would be established for each nuclear unit's EDGs [these reliability levels would comport with the reliability levels assumed in a licensee's coping analysis for station blackout (SBO)]; (2) trigger values would be established with respect to EDG failures to provide an "early warning" of reliability degradation, to address degradation in an individual EDG, and to provide a basis for taking regulatory action (including the possibility of enforcement action) when it becomes clear that the target reliability level is not being met by a licensee; and (3) a reporting regime would be established in accordance with this approach.

In addition, the Commission requested that when the staff submits the proposed rule for Commission approval, the staff should identify proposed regulatory actions to be taken, including enforcement action when the "double trigger" criterion occurs.

Discussion:

The staff has prepared a Federal Register Notice (Enclosure 1) which includes a revised rule and revised Regulatory Guide 1.9, Rev. 3 (Enclosure 2) which responds to the Commission's SRM.

The Federal Register Notice (FRN) provides a background discussion; discusses the need for the proposed rule amendment, the proposed monitoring of EDG reliability and enforcement considerations; and includes a backfit analysis.

The proposed rule amendment is based on monitoring failures and successes of EDGs to start and load-run, and uses the following performance-based criteria:

1) EARLY WARNING: If there are 3 failures in the last 20 demands for either an individual EDG or for all EDGs assigned to a nuclear unit, this is an early indicator of deterioration of EDG reliability. The NRC is to be notified in writing of this condition within 30 days and the licensee is expected to take appropriate corrective action.

2) PROBLEM DIESEL: If there are 4 failures in the last 25 demands of an EDG, this is further indication of EDG reliability deterioration and also ineffectiveness of the on-site EDG maintenance program. A written report to the NRC is required within 30 days. Following corrective action, this EDG is to be subjected to accelerated testing per RG 1.9, Rev. 3 (proposed) to demonstrate effectiveness of maintenance actions (i.e., 7 consecutive failure free tests).

3) DOUBLE TRIGGER: If there are 5 failures within the last 50 demands and 8 failures within the last 100 demands (nuclear unit target reliability = 0.95), or 4 failures within the last 50 demands and 5 failures within the last 100 demands (nuclear unit target reliability = 0.975), then this is clear evidence that the EDG maintenance activities are not effective and that the EDG reliability level has dropped below the selected target. This condition is clearly non-compliance with the proposed rule (§50.63(a).

If the above failure rates occur, the license should: (1) implement appropriate corrective action; (2) notify the NRC Operations Center within 24 hours; (3) if restoration of nuclear unit EDG reliability has not been demonstrated within 30 days of the occurence of the "double triggers", send a written report to the Director, Nuclear Reactor Regulation stating the

cause(s) for this condition, the basis on which the EDGs are considered operable, and a description and schedule for corrective action designed to restore EDG reliability to assumed values.

Regulatory Guide 1.9, Revision 3 (second proposed revision) has been revised to provide guidance for: EDG surveillance testing for monitoring EDG reliability, calculating reliability levels, recordkeeping and reporting requirements to supplement the proposed rule amendment.

More recently, questions related to EDG maintenance activities and their effects on EDG unavailability have been raised. In developing the EDG reliability levels selected for the SBO rule, unavailability due to testing and maintenance was assumed to contribute a small amount (0.007 per EDG) to overall unavailability. Cumulative EDG outage time due to maintenance activities could be an important contributor to diesel unavailibility, but no explicit limit on availability was specified. However, the Technical Specifications Improvement program, which is based on risk and reliability considerations, was selected as the vehicle for implementing allowable cumulative unavailability for diesels rather than incorporating such requirements in the rules.

AEOD recently evaluated operational events during CYs 1985 to 1990 that involved EDG performance following undervoltage conditions on associated safety buses during reactor power operation (REF. AEOD Special Study Report AEOD/S91-01, September 1991).

The estimated effect on EDG reliability because of unavailability related to maintenance is 0.039 based on AEOD's evaluation of 128 recent demands (five of which occured while the diesel was out of service for maintenance). The estimated unavalibility is 0.01 to 0.09 based on 95% confidence limits. Although these estimates

are higher than the 0.007 maintenance unavailibility contribution cited in Regulatory Guide 1.155, the guide clearly states that in some cases outages due to maintenance can be a significant contributor to EDG unavailability. The guide also notes that this contribution can be kept low by having high-quality test and maintenance procedures and by scheduling regular diesel generator maintenance so as to minimize the risk on plant operation.

The AEOD report also examined those events where the cause of the event also prevented sucessful restoration of ac power. There were 5 failures in 119 such applicable events.

The estimated reliability of an EDG based on this data set is 0.96 and the associated 95% confidence limits are 0.90 and 0.99.

Overall, the AEOD report indicates that based on demands initiated by an actual loss of preferred power to a safety bus, the capability of the EDGs to automatically start, load their respective safety buses, and provide power to the engineered safety features is within the range of the reliability goal of 0.95 suggested in Regulatory Guide 1.155 to cope with station blackout and that some uncertainty is unavoidable due to the relatively small sample size and the need to interpret the information in the LERs.

The AEOD report further notes that the major portion of dead bus events was due to maintenance and testing, and that the practice of on-line maintenance of EDGs needs to be examined by licensees and efforts made to minimize the negative impact on system availability.

The potential impact of maintenance related unavailability on diesel generator reliability levels and the need to minimize such unavailability by scheduling EDG maintenance so as to minimize potential risks during power operation and during refueling

outages has been incorporated into the proposed Regulatory Guide 1.9, Revision 3.

COORDINATION: This Commission paper has been prepared by the Office of Nuclear Regulatory Research in close co-ordination with the Office of Nuclear Reactor Regulation, the Office of Enforcement and the Office of General Council. The Office of General Council has reviewed this paper and has no legal objection to it.

SUMMARY: The staff requests that Commission approval be granted to issue the enclosed Federal Register Notice and Regulatory Guide 1.9, Revision 3 for public comment.

James M. Taylor
Executive Director
for Operations

Enclosures:
1. Federal Register Notice (proposed rule with statement of considerations)
2. Regulatory Guide 1.9, Revision 3 (proposed)
3. Environmental Assessment

NUCLEAR REGULATORY COMMISSION

10 CFR Part 50

RIN _____

LOSS OF ALL ALTERNATING CURRENT POWER

AGENCY: Nuclear Regulatory Commission

ACTION: Proposed Rule

SUMMARY: The Nuclear Regulatory Commission is proposing to amend its requirements for the reliability of the onsite emergency ac sources to assure that the probability of losing onsite emergency ac power sources is minimized and that emergency diesel generator reliability target levels selected for compliance with the station blackout rule, 10 CFR Part 50.63, are being achieved and maintained. The station blackout (SBO) rule requires that light-water-cooled nuclear power plants be able to withstand for a specified duration and recover from a station blackout. The reliability of onsite emergency ac power sources is one of four factors specified in 10 CFR 50.63 to determine the station blackout coping duration for each plant.

DATES: Submit comments by [75 days after publication date] ,1992. Comments received after this date will be considered if it is practical to do so, but the Commission is able to assure consideration only for comments received on or before this date.

ADDRESSEES: Comments may be sent to: The Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, DC 20555, ATTN: Docketing and Service Branch, or may be hand delivered to the Office of the Secretary, One White Flint North, 11555 Rockville Pike, Rockville, Maryland, between 7:45 a.m. and 4:15 p.m. Federal workdays. Copies of comments received may be examined at the NRC Public Document Room, 2120 L Street NW. (Lower Level), Washington, DC.

FOR FURTHER INFORMATION CONTACT:

Aleck Serkiz, Division of Safety Issue Resolution, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555, Telephone (301) 492-3942

SUPPLEMENTARY INFORMATION:

Background

The Commission's existing regulations (See General Design Criteria 17 and 18, 10 CFR Part 50, Appendix A) establish requirements for the design and testing of onsite and offsite electric power systems that are intended to reduce the probability of losing all ac power. The statement of considerations for 10 CFR 50.63 (see 53FRN23203, June 21, 1988) noted that the reliability of onsite emergency ac power sources is one of the main factors contributing to risk of core melt resulting from station blackout. The statement of considerations also noted that resolution of Generic Safety Issue B-56, Diesel Generator Reliability, would provide specific guidance for use by the staff or industry to "review the adequacy of diesel generator reliability programs consistent with the resolution of USI A-44."

Staff guidance for EDG selection, design, qualification and testing is currently provided in the following three documents: (1) Regulatory Guide 1.9, Revision 2, (2) Regulatory Guide 1.108, Revision 1, and (3) Generic Letter 84-15. The staff proposed to revise Regulatory Guide 1.9, Revision 2, to incorporate guidance for: (1) EDG surveillance testing utilizing industry-wide accepted definitions for valid starts and failures, (2) monitoring of EDG reliability levels for consistency with the requirements of GDCs 17, 18 and 10 CFR 50.63 and to incorporate,as appropriate, guidance from NUMARC-8700, Appendix D revision dated 5-2-90 (which defined an EDG reliability program). The staff also proposed to endorse NUMARC's Initiative 5A and issue a 50.54(f) letter that requested endorsement of the EDG reliability program provided in RG 1.9, Rev. 3 or identification of an equivalent EDG reliability program. The Commission has determined that a rule revision is the appropriate means for imposing new requirements related to emergency diesel generator reliability.

Need for the Proposed Amendment

If loss of normally available alternating current (ac) power occurs at a nuclear power plant, redundant onsite emergency ac power sources provide power for necessary safety functions which include reactor core decay heat removal (GDC 34), emergency core cooling (GDC 35) and containment heat removal (GDC 38). These systems are essential for preserving the integrity of the reactor core, reactor coolant system and containment. Although reactor core decay heat can be removed for a limited time by systems that are independent of ac power, Class 1E emergency diesel generators (EDGs) are the long term power source for these systems in most plants. Therefore, the reliability of emergency diesel generators is a major factor in assuring acceptable plant safety.

The Commission has determined that a rule requiring EDG testing and monitoring is necessary to assure that adequate EDG reliability levels are being maintained. Furthermore, demonstration of EDG reliability should be based on a results-oriented approach, consistent with the approach taken in the maintenance rule (10 CFR 50.65). This approach would consist of (1) establishment of EDG target reliability levels which would comport with the reliability levels assumed in a licensee's coping analysis for station blackout, (2) trigger values with respect to EDG failures, to serve two

purposes -- to provide an "early warning" of EDG degradation, and to provide a basis for taking regulatory action when it becomes clear that the target reliability is not being met by a licensee, and (3) a reporting regime for EDG failures consistent with the approach described above.

Monitoring of EDG Performance

The monitoring of EDG performance (i.e., failures and successes) will be based primarily on surveillance tests which subject the diesels to "start" and "load-run" cycles as discussed in Regulatory Guide 1.9, Revision 3 (proposed). In addition, unplanned starts and load-runs will occur during the normal operations cycle. The combination of surveillance tests and unplanned EDG start and load-run demands will provide a data base for estimating EDG reliability levels for comparison to target values selected for the station blackout coping analysis.

This data base can be used to estimate nuclear unit EDG reliability, but only within the constraints that a proper statistical analysis imposes. The overall goal is to develop a method that maximizes the probability of detecting a real decrease in EDG reliability while minimizing the probability of indicating a decrease when none actually occurred (a false alarm). These are competing requirements. In addition, the uncertainty of the estimate varies with the sample size (i.e., the number of tests). Estimating reliability with a high confidence level requires a large number of tests. However, a large number of tests take a long time so that the resulting estimate also would not be available for a long time.

The following "double trigger" values were selected as a compromise to maximize detection probability and minimize false alarms:

Nuclear Unit EDG Target Reliability	Double Trigger (Failures/Demand)
0.95	5/50 and 8/100
0.975	4/50 and 5/100

These triggers provide clear evidence that EDG reliability has degraded to an unacceptable level. However the response time is slow. Assuming monthly testing plus unplanned demands, two years could pass before 100 demands occurred. Therefore an early warning trigger [3 failures in the last 20 demands] is needed. This trigger serves as an indicator of the possible onset of reliability degradation.

These triggers are based on the total number of failures and demands at all of the EDG at a nuclear unit. Thus they monitor the overall reliability of the emergency onsite power system. In order to monitor the reliability of individual EDGs and to provide an early warning, a 3/20 trigger would also be applied to the performance of any individual EDG. In addition, a trigger of 4 failures in the last 25 demands on any individual EDG is an indication of continued degradation of reliability for that EDG and the ineffectiveness of the licensee's maintenance program.

In summary, monitoring of EDG performance from a results-oriented perspective would be based on monitoring failures and successes to start and load-run, and utilize the following criteria:

1) EARLY WARNING: If there are 3 failures within the last 20 last demands for either an individual EDG or for all EDGs assigned to a nuclear unit, this is an early indicator of potential deterioration of EDG reliability. The NRC should be notified and corrective action taken by the licensee.

2) PROBLEM DIESEL: If there are 4 failures in the last 25 demands of an EDG, this is a further indication of EDG reliability deterioration and also the ineffectiveness of the EDG maintenance program. Following corrective action this EDG should be subjected to accelerated testing to demonstrate effectiveness of maintenance actions (i.e., 7 consecutive failure free tests).

3) DOUBLE TRIGGER: If there are 5 failures within the last 50 demands and 8 failures within the last 100 demands (nuclear unit target reliability = 0.95), or 4 failures within the last 50 demand and 5 failures within the last 100 demands (nuclear unit target reliability = 0.975), then this is clear evidence that EDG maintenance activities are not effective and that the EDG reliability level has dropped significantly below the target level. This condition is clearly non-compliance with §50.63(a) and regulatory action should be taken. The actions and reporting requirements of §50.63(a)(3)(ii)(C) should be carried out.

Enforcement Considerations:

The early warning report (3 failures in the last 20 demands) is subject to NRC review or inspection to determine underlying causes and corrective actions planned or carried out. Enforcement action will not be taken solely as a result of the early warning report, but some action(including escalated action) may result from associated staff activities should violation of other requirements such as Criterion XVI of Appendix B of 10 CFR 50 be identified.

Occurrence of the double trigger is clear evidence that the licensee is not maintaining EDG reliability levels and that the nuclear unit EDG reliability level has dropped below the reliability target selected by the licensee in determining the specified station blackout duration required by 10 CFR 50.63(a). This condition is clearly non-compliance with §50.63(a) and regulatory action should be taken. The actions and reporting requirements of §50.63(a)(3)(ii)(C) should be carried out.

The Commission intends, as part of the final rulemaking in this matter, to modify the NRC enforcement policy in 10 CFR Part 2, Appendix C. Specifically, the Commission would modify Supplement I of Appendix C to identify that failure to report conditions as required by this rulemaking is an example of a Severity Level III.

In addition, the Commission would modify Supplement I to provide that failure to take corrective action as required by Appendix B of Part 50 such

that the double trigger value in 10 CFR 50.63(a)(3)(ii)(C) is reached would be considered an example of a Severity Level III violation. Civil penalties are normally assessed for Severity Level III violations absent mitigating conditions. Given that a licensee will only exceed the double trigger after exceeding the early warning trigger in section 50.63(a)(3)(ii)(A) and not taking effective corrective action, it will be appropriate in assessing a civil penalty to escalate the penalty for prior notice and not to mitigate the penalty for prior performance. The licensee's response to exceeding the double trigger will be considered in determining if daily civil penalties should be imposed for each day the facility operated while exceeding the double trigger level. By these enforcement positions, the Commission will be emphasizing the importance of having reliable diesel generators. This rule does not prohibit operation of a facility with diesels having less than the expected reliability provided the diesels are operable as required by the facility's technical specifications action statements. However, prior to making the decision to operate with less than the expected EDG reliability and face daily civil penalties, the licensee must make the required operability evaluation, as it must whenever a diesel fails, and follow the technical specifications if a diesel is determined to be inoperable.

FINDING OF NO SIGNIFICANT ENVIRONMENTAL IMPACT:

The Commission has determined under the National Environmental Policy Act of 1969, as amended, and the Commission's regulations in Subpart A of 10 CFR Part 51, that this rule, if adopted, would not be a major Federal action significantly affecting the quality of the human environment and therefore an environmental impact statement is not required. The environmental assessment and finding of no significant impact are available for inspection and copying for a fee at the NRC Public Document Room, 2120 L Street, N.W., (Lower Level), Washington, D.C. between the hours of 7:45 a.m. and 4:15 p.m. on Federal workdays. Single copies of the environmental assessment and finding of no significant impact are available from Mr. Warren Minners, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Telephone: (301) 492-3900.

PAPERWORK REDUCTION ACT STATEMENT

This proposed rule change amends information collection requirements pertaining to 10 CFR 50.63 that are subject to the Paperwork Reduction Act of 1980 (44 U.S.C. 3501 et seq.). This rule has been submitted to the Office of Management and Budget for review and approval of the paperwork requirements.

Public burden for this collection of information is estimated to average ____ hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to the Information and Records Management Branch (P-530), U.S. Nuclear Regulatory Commission, Washington, DC 20555; and to the Paperwork Reduction Project (3150-), Office of Management and Budget, Washington, DC 20503.

REGULATORY ANALYSIS

The Commission did not prepare a separate regulatory analysis for the proposed rule, because the existing regulatory analysis (NUREG-1109) for the Station Blackout Rule assumed, and therefore considered, the need for licensees to monitor their emergency diesel generators and meet their established reliability targets. The proposed rule requires licensees to monitor the performance of emergency diesel generators and take appropriate action if measured reliability falls below the reliability targets established by the licensees in conformance with the requirements of Section 50.63(a)(1) of the Station Blackout Rule. However, as the backfit analysis for the Station Blackout Rule makes clear, such monitoring and reliability-achievement requirements were presumed to be part of the regulatory scheme for the Station Blackout Rule.

The resolution of USI A-44 "Station Blackout" (see 53 FRN 23217-8) included a regulatory guide that provided guidance on emergency diesel generator (EDG) reliability (Regulatory Guide 1.155, Sections C1.1 and C1.2). That guidance identified EDG reliability targets of 0.95 (Group A,B and C plants) and 0.975 (Group D plants). It was noted that these reliability levels will be considered minimum target reliabilities and that each plant should have an EDG reliability program containing the principal elements, or their equivalent, outlined in Regulatory position C1.2, which included surveillance testing and reliability monitoring and an information and data collection system. The FRN further noted that the resolution of B-56 would provide specific guidance for use by the staff or industry to review the adequacy of EDG reliability programs consistent with the resolution of USI A-44.

The Commission now believes that detailed prescriptive guidance on the content of emergency diesel generator reliability monitoring programs is not warranted. Therefore the proposed rule sets forth the criteria which a monitoring program must meet, establishes criteria for determining whether reliability may be decreasing and whether target reliabilities are being met, and specifies the actions which must be taken if reliability targets are not met.

However, since the Station Blackout Rule and its regulatory analysis assumed that such monitoring would be performed and that reliability targets would have to be met, the Commission believes that a new regulatory analysis for the proposed rule which explicitly establishes these actions as regulatory requirements would be largely duplicative.

Moreover, the regulatory analysis for the Station Blackout Rule assumed that most licensees were already performing some type of reliability monitoring, and that only 10 licensees would be required to incur additional costs for upgrading their diesel generator monitoring programs. The Commission does not believe that licensees have reduced their monitoring since the preparation of the regulatory analysis for the Station Blackout Rule. Therefore, the Commission concludes that the cost estimates for this proposed rule, which would explicitly require monitoring and compliance with licensee-established Station Blackout Rule reliability targets, are enveloped by the regulatory analysis for the Station Blackout Rule.

For these reasons, a new regulatory analysis for this proposed rule was not prepared.

BACKFIT ANALYSIS

The proposed rule establishes requirements for monitoring the performance of emergency diesel generators and requires licensees to take appropriate action if measured reliability falls below the reliability targets established by the licensees in conformance with the requirements of Section 50.63(a)(1) of the Station Blackout Rule. The backfit analysis for Section 50.63, which was published in the Federal Register along with the final rule (53 FR 23210; June 21, 1988), specifically assumed that licensees would be required to maintain a reliability level of either .95 or .975, and included the costs for development of procedures and corrective actions if diesel generator reliability fell below the specified reliability levels. See 53 FR at 23216, 23217. Thus, the backfit analysis for the Station Blackout rule essentially enveloped the requirements of this proposed rule. Preparation of a new backfit analysis for this proposed rule would be essentially duplicative of the prior backfit analysis with respect to monitoring and maintaining diesel generator reliability. For this reason, a separate backfit analysis for this proposed rule was not prepared.

LIST OF SUBJECTS IN 10 CFR PART 50

Nuclear power plants and reactors, Reporting and record keeping requirements.

For the reasons set out in the preamble and under the authority of the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, and 5 U.S.C. 553, the NRC is proposing to adopt the following amendment to 10 CFR 50.63.

PART 50 - DOMESTIC LICENSING
OF PRODUCTION AND UTILIZATION FACILITIES

1. The authority citation for Part 50 continues to read in part as follows:

Authority Section 161, 68 Stat. 948, as amended (42 USC 2201); Sec. 201, 88, Stat. 1242, as amended, (42 U.S.C. 5841) ***

2. Section 50.63(a) is amended by adding paragraphs (a)(3) and (d) to read as follows:

§50.63 Loss of alternating current power

(a)(1) * * * *

(2) * * * * *

(3)(i) Diesel generators that are relied upon to provide on-site emergency ac power (emergency diesel generators) must meet the reliability target selected by the licensee in determining the specified station blackout duration required by paragraph (a)(1) of this section.

(ii) The reliability of every emergency diesel generator must be monitored at least monthly to determine whether the reliability

target selected by the licensee in determining the specified station blackout duration required by paragraph (a)(1) of this section is being met. All data from planned and unplanned demands must be used in determining the emergency diesel generator reliability. The starting baseline nuclear unit reliability will be based on all emergency diesel failures that have occurred in the last 100 demands of all the emergency diesel generators for that nuclear unit.

(A) If there are 3 failures out of the last 20 demands for either an individual emergency diesel generator or at any nuclear unit (i.e. combining the performance data for all emergency diesel generators assigned to a given nuclear unit rather than based on each individual emergency diesel generator), the licensee **shall** submit a **written** report to the NRC within 30 days of reaching the failure condition of this paragraph stating the cause(s) for this condition and the nuclear unit EDG reliability level.

(B) If there are 4 failures out of the last 25 demands of an emergency diesel generator, the licensee shall test that emergency diesel generator at a period between tests of no less than 24 hours and no more than 7 days, until 7 consecutive failure free tests are achieved, or the emergency diesel generator passes alternative tests that have been approved by the NRC. The licensee **shall** submit a **written** report to the NRC within 30 days of reaching the failure condition of this paragraph stating the cause(s) for this condition, the EDG reliability for the nuclear unit and planned corrective action.

(C) If, for a selected reliability target of 0.95, there are 5 failures **within** the last 50 demands and 8 failures **within** the last 100 demands, or for a selected reliability target of 0.975, there are 4 failures **within** the last 50 demands and 5 failures **within** the last 100 demands at any nuclear unit (i.e., combining the performance data for all emergency diesel generators assigned to a given nuclear unit rather than to each individual emergency diesel generator), reaching the applicable failure condition set forth in this paragraph will also be deemed to be a noncompliance with the requirements of paragraph (a)(3) of this section.

If the above failure rates occur, the licensee shall: (1) implement appropriate corrective action; (2) notify the NRC Operations Center within twenty-four hours; and (3) if restoration of nuclear unit EDG reliability has not been demonstrated within thirty days of the occurrence of the above failure rates, send a written report to the Director, Nuclear Reactor Regulation stating the cause(s) for this condition, the basis on which the EDGs are considered operable, and a description and schedule for corrective action designed to restore EDG reliability to assumed values.

* * * * * * * * * * *

(d) Compliance with 50.63(a)(3): Each light-water-cooled nuclear power plant licensed to operate on or before [date of

publication], must comply with 10 CFR 50.63(a)(3) six months after the rule becomes effective.

SECOND PROPOSED REVISION 3 TO REGULATORY GUIDE 1.9
(Task RS 802-5)

SELECTION, DESIGN, QUALIFICATION, TESTING, AND RELIABILITY OF EMERGENCY DIESEL GENERATOR UNITS USED AS CLASS 1E ONSITE ELECTRIC POWER SYSTEMS AT NUCLEAR POWER PLANTS

A. INTRODUCTION

Criterion 17, "Electric Power Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires that onsite electric power systems have sufficient independence, capacity, capability, redundancy, and testability to ensure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences, and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents, assuming a single failure.

Criterion 18, "Inspection and Testing of Electric Power Systems," of Appendix A to 10 CFR Part 50 requires that electric power systems important to safety be designed to permit appropriate periodic inspection and testing to assess the continuity of the systems and the condition of their components.

Criterion III, "Design Control," and Criterion XI, "Test Control," of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 require that (1) measures be provided for verifying or checking the adequacy of design by design reviews, by the use of alternative or simplified calculational methods, or by the performance of a suitable testing program, and (2) a test program be established to ensure that systems and components perform satisfactorily and that the test program include operational tests during nuclear power plant operation.

Section 50.63, "Loss of All Alternating Current Power," of 10 CFR Part 50 requires that each light-water-cooled nuclear power plant be able to withstand and recover from a station blackout (i.e., loss of offsite and onsite emergency ac power systems) for a specified duration. The reliability of onsite emergency ac power sources is one of the main factors contributing to risk of core melt resulting from station blackout.

Diesel generator units have been widely used as the power source for onsite electric power systems. This regulatory guide provides guidance acceptable to the NRC staff for complying with the Commission's requirements that diesel generator units intended for use as onsite emergency power sources in nuclear power plants be selected with sufficient capacity, be qualified, and have the necessary reliability and availability for station blackout and design basis accidents.

This guide has been prepared for the resolution of Generic Safety Issue B-56, "Diesel Generator Reliability," and is related to Unresolved Safety Issue (USI) A-44, "Station Blackout." The resolution of USI A-44 established a need for an emergency diesel generator (EDG) reliability program that has the capability to achieve and maintain the EDG reliability levels in the range of 0.95 per demand or better to cope with station blackout.

This guide recognizes that, unless emergency diesel generators are properly maintained, their capabilities to perform on demand may degrade. The reliability of the EDGs should be monitored and conditions trended during testing.

[Insert for ACRS approval will be added later]

All previous licensing commitments based on Regulatory Guide 1.9, Revision 2, and Regulatory Guide 1.108, Revision 1, are considered to be in effect until a licensee revises plant technical specifications.

The regulatory basis for information collection activities mentioned in this regulatory guide are contained as requirements in 10 CFR Part 50, which provides the regulatory basis for this guide. The information collection requirements in 10 CFR Part 50 have been cleared under OMB Clearance No. 3150-0011.

B. DISCUSSION

An emergency diesel generator unit selected for use in an onsite electric power system should have the capability to (1) start and accelerate a number of large motor loads in rapid succession while maintaining voltage and frequency within acceptable limits, (2) provide power promptly to engineered safety features if a loss of offsite power and an accident occur during the same time period, and (3) supply power continuously to the equipment needed to maintain the plant in a safe condition if an extended loss of offsite power occurs.

IEEE Std 387-1984,[1] "IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations," delineates principal design criteria and qualification and testing guidelines that, if followed, will help ensure that selected diesel generator units meet performance requirements. (IEEE Std 387-1977 was endorsed by Revision 2 of Regulatory Guide 1.9, "Selection, Design, and Qualification of Diesel Generator Units Used as Standby (Onsite) Electric Power Systems at Nuclear power Plants.") IEEE Std 387-1984 was developed by Working Group 4.2C of the Nuclear Power Engineering Committee (NPEC) of the Institute of Electrical and Electronics Engineers, Inc. (IEEE), approved by NPEC, and subsequently approved by the IEEE Standards Board on March 11, 1982. Std 387-1984 is supplementary to IEEE Std 308-1974, "IEEE Standard Criteria for Class 1E Power Systems and Nuclear Power Generating Stations," and specifically amplifies paragraph 5.2.4, "Standby Power Supplies," of IEEE Std 308 with respect to the application of diesel generator units. IEEE Std 308-1974 is endorsed, with certain exceptions, by Regulatory Guide 1.32, "Criteria for Safety Related Electric Power Systems for Nuclear Power Plants."

IEEE Std 387-1984 also references other standards that contain valuable information. Those referenced standards not endorsed by a regulatory guide or incorporated into the regulations, if used, are to be used in a manner consistent with current regulations.

A knowledge of the characteristics of each load is essential in establishing the bases for the selection of an emergency diesel generator unit that is able to accept large loads in rapid succession. The majority of the emergency loads are large induction motors. This type of motor draws, at full voltage, a starting current five to eight times its rated load current. The sudden large increases in current drawn from the diesel generator resulting from the startup of induction motors can result in substantial voltage reductions. The lower voltage could prevent a motor from starting, i.e., accelerating its load to rated speed in the required time, or could cause a running motor to coast down or stall. Other loads might be lost because of low voltage if their contactors drop out. Recovery from the transient caused by starting large motors or from the loss of a large load could cause diesel engine overspeed that, if excessive, might result in a trip of the engine, i.e., loss of the Class 1E power source. These same

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[1] Copies may be obtained from the Institute of Electrical and Electronics Engineers, Inc., IEEE Service Center, 445 Cohoes Lane, P. O. Box 1331, Piscataway, NJ 08855.

consequences can also result from the cumulative effect of a sequence of more moderate transients if the system is not permitted to recover sufficiently between successive steps in a loading sequence.

Generally it has been industry practice to specify a maximum voltage reduction of 10 to 15 percent when starting large motors from large capacity power systems and a voltage reduction of 20 to 30 percent when starting these motors from limited-capacity power sources such as diesel generator units. Large induction motors can achieve rated speed in less than 5 seconds when powered from adequately sized emergency diesel generator units that are capable of restoring the bus voltage to 90 percent of nominal in about 1 second.

Protection of the emergency diesel generator unit from excessive overspeed, which can result from an improperly adjusted control system or governor failure, is afforded by the immediate operation of a diesel generator unit trip, usually set at 115 percent of nominal speed. Similarly, in order to prevent substantial damage to the generator, the generator differential current trip must operate immediately upon occurrence of an internal fault. There are other protective trips provided to protect the emergency diesel generator units from possible damage. However, these trips could interfere with the successful functioning of the unit when it is most needed, i.e., during accident conditions. Experience has shown that there have been numerous occasions when these trips have needlessly shut down emergency diesel generator units because of spurious operation of a trip circuit. Consequently, it is important that measures be taken to ensure that spurious actuation of these other protective trips does not prevent the emergency diesel generator unit from performing its function.

The uncertainties inherent in estimates of safety loads at the construction permit stage of design are sometimes of such magnitude that it is prudent to provide a substantial margin in selecting the load capabilities of the emergency diesel generator unit. This margin can be provided by estimating the loads conservatively and selecting the continuous rating of the emergency diesel generator unit that exceeds the sum of the loads needed at any one time. A more accurate estimate of safety loads is possible during the operating license stage of review because detailed designs have been completed and component test and preoperational test data are usually available. However, the sum of the total loads at the operating license stage should not exceed the continuous rating of the EDG.

The reliability of emergency diesel generators is one of the

main factors affecting the risk of core damage from a station blackout event. Thus, attaining and maintaining high reliability of emergency diesel generators at nuclear power plants is a major contributor to the reduction of the probability of station blackout. In Regulatory Guide 1.155, "Station Blackout," the reliability of the diesel generator is one of the factors to be used to determine the length of time a plant should be able to cope with a station blackout. If all other factors (redundancy of emergency diesel generators, frequency of loss of offsite power, and probable time needed to restore offsite power) remain constant, a higher reliability of the diesel generators will result in a lower probability of a total loss of ac power (station blackout) with a corresponding coping duration for certain plants according to Regulatory Guide 1.155.

High reliability should be designed into the emergency diesel generator units and maintained throughout their service lifetime. This can be achieved by appropriate testing, maintenance, and operating programs and by institution of a reliability program designed to monitor, improve, and maintain reliability at selected levels.

This guide provides explicit guidance in the areas of preoperational testing, periodic testing, reporting requirements, and valid demands and failures. The preoperational and periodic testing provisions set forth in this guide provide a basis for taking corrective actions needed to maintain high inservice reliability of installed emergency diesel generator units. The data base developed will provide an ongoing demonstration of performance and reliability for all emergency diesel generator units after installation and during service.

This revision of Regulatory Guide 1.9 integrates into a single regulatory guide pertinent guidance previously addressed in Revision 2 of Regulatory Guide 1.9, Revision 1 of Regulatory Guide 1.108, and Generic Letter 84-15, and it endorses, as appropriate, guidelines set forth in IEEE Std 387-1984. In addition, this guide describes a means for meeting the minimum diesel generator reliability goals in Regulatory Guide 1.155 and remedial actions to restore EDG reliability to levels selected for compliance with 10 CFR 50.63.

During the development of this regulatory guide, the Nuclear Management and Resources Council (NUMARC) revised NUMARC-8700, "Guidelines and Technical Bases for NUMARC Initiatives Addressing

Station Blackout at Light Water Reactors."[2] Revision 1 of Appendix D, "EDG Reliability Program" (5-2-90), to NUMARC-8700 provides additional guidance for monitoring the performance of nuclear unit emergency diesel generator reliability levels and identifies possible remedial actions to restore emergency diesel generator reliability to meet those values selected for station blackout.

C. REGULATORY POSITION

This regulatory guide describes a means acceptable to the NRC staff for monitoring the target EDG reliability levels selected for compliance with 10 CFR 50.63.

Conformance with the guidelines in IEEE Std 387-1984, "IEEE Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations," is acceptable to the NRC staff for satisfying the Commission's regulations with respect to design, qualification, and periodic testing of diesel generator units used as onsite electric power systems for nuclear power plants subject to the following:

1. DESIGN CONSIDERATIONS

The guidelines of IEEE Std 387-1984 should be supplemented as follows:

1.1 Section 1.2, "Inclusions," of IEEE Std 387-1984 should be supplemented to include diesel generator auto controls, manual controls, and diesel generator output breaker.

1.2 When the characteristics of the required emergency diesel generator loads are not accurately known, such as during the construction permit stage of design, each emergency diesel generator unit of an onsite power supply system should be selected to have a continuous load rating (as defined in Section 3 7.1 of IEEE Std 387-1984) equal to or greater than the sum of the conservatively estimated loads (nameplate) needed to be powered by that unit at any one time. In the absence of fully substantiated performance characteristics for mechanical equipment such as pumps, the electric motor drive ratings should be calculated using conservative estimates of these characteristics, e.g., pump runout conditions and motor efficiencies of 90 percent or less and power

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[2] NUMARC-8700 and Appendix D (Rev. 1, May 2, 1990) are available for inspection or copying for a fee at the Commission's Public Document Room, 2120 L Street, N.W., Washington, DC in the file for Regulatory Guide 1.9.

factors of 85 percent or lower.

1.3 At the operating license stage of review, the predicted loads should not exceed the continuous rating (as defined in Section 3.7.1 of IEEE Std 387-1984) of the diesel generator unit.

1.4 Section 5.1.2, "Mechanical and Electrical Capabilities," of IEEE Std 387-1984 pertains, in part, to the starting and load-accepting capabilities of the diesel generator unit. In conformance with Section 5.1.2, each diesel generator unit should be capable of starting and accelerating to rated speed, in the required sequence, all the needed engineered safety feature and emergency shutdown loads. The diesel generator unit design should be such that at no time during the loading sequence should the frequency decrease to less than 95 percent of nominal nor the voltage decrease to less than 75 percent of nominal (a larger decrease in voltage and frequency may be justified for a diesel generator unit that carries only one large connected load). Frequency should be restored to within 2 percent of nominal in less than 60 percent of each load-sequence interval for steploaad increase and in less than 80 percent of each load-sequence interval for disconnection of the single largest load, and voltage should be restored to within 10 percent of nominal within 60 percent of each load-sequence time interval. (A greater percentage of the time interval may be used if it can be justified by analysis. However, the load-sequence time interval should include sufficient margin to account for the accuracy and repeatability of the load-sequence timer.) During recovery from transients caused by the disconnection of the largest single load, the speed of the diesel generator unit should not exceed the nominal speed plus 75 percent of the difference between nominal speed and the overspeed trip setpoint or 115 percent of nominal, whichever is lower. Furthermore, the transient following the complete loss of load should not cause the speed of the unit to attain the overspeed trip setpoint.

1.5 Emergency diesel generator units should be designed to be testable as discussed in Regulatory Position 2. The design should include provisions so that testing of the units will simulate the parameters of operation (manual start, automatic start, load sequencing, load shedding, operation time, etc.), normal standby conditions, and environments (temperature, humidity, etc.) that would be expected if actual demand were to be placed on the system. If prewarm systems designed to maintain lube oil and jacket water cooling at certain temperatures or prelubrication systems or both are normally in operation, this would constitute normal standby conditions for that plant.

The units should be designed to automatically transfer from

the test mode to an emergency mode upon receipt of emergency signals.

1.6 Design provisions should include the capability to test each emergency diesel generator unit independently of the redundant units. Test equipment should not cause a loss of independence between redundant diesel generator units or between diesel generator load groups. Testability should be considered in the selection and location of instrumentation sensors and critical components (e.g., governor, starting system components). Instrumentation sensors should be readily accessible and designed so that their inspection and calibration can be verified in place. The overall design should include status indication and alarm features.

1.7 Section 5.5.3.1, "Surveillance Systems," of IEEE Std 387-1984 pertains to status indication of diesel generator unit conditions. The guidance in this section should be supplemented as follows:

1.7.1 A surveillance system should be provided with remote indication in the control room for displaying emergency diesel generator unit status, i.e., under test, ready-standby, lockout. A means of communication should also be provided between diesel generator unit testing locations and the main control room to ensure that the operators are cognizant of the status of the unit under test.

1.7.2 In order to facilitate trouble diagnosis, the surveillance system should indicate which of the emergency diesel generator protective trips has been activated first.

1.8 Section 5.5.4, "Protection," of IEEE Std 387-1984, which pertains to bypassing emergency diesel generator protective trips during emergency conditions, should be supplemented as follows:

The emergency diesel generator unit should be automatically tripped on an engine overspeed and generator-differential overcurrent. All other diesel generator protective trips should be handled in one of two ways: (1) a trip should be implemented with two or more measurements for each trip parameter with coincident logic provisions for trip actuation, or (2) a trip may be bypassed under accident conditions provided the operator has sufficient time to react appropriately to an abnormal diesel generator unit condition. The design of the bypass circuitry should include the capability for (1) testing the status and operability of the bypass circuits, (2) alarming in the control room for abnormal values of all bypass parameters (common trouble alarms may be used), and (3)

manually resetting the trip bypass function. Capability for automatic reset is not acceptable.

Section 5.5.4(2) of IEEE Std 387-1984, on retaining all protective devices during emergency diesel generator testing, does not apply to a periodic test that demonstrates diesel generator system response under simulated accident conditions per Regulatory Positions 2.2.5, 2.2.6, and 2.2.12.

2. DIESEL GENERATOR TESTING

Section 3, "Definitions," Section 6, "Testing,"[3] and Section 7, "Qualification Requirements," in IEEE Std 387-1984 should be supplemented as discussed below.

2.1 Definitions

The following definitions[4] are applicable to the positions of this regulatory guide that address testing, reliability calculations, recordkeeping, and reporting of performance.

Start demands: All valid and inadvertent start demands, including all start-only demands and all start demands that are followed by load-run demands, whether by automatic or manual initiation. A start-only demand is a demand in which the emergency generator is started, but no attempt is made to load the emergency diesel generator. See "Exceptions" below.

Start failures: Any failure within the emergency generator system that prevents the generator from achieving specified frequency (or speed) and voltage is classified as a valid start failure. (For the monthly surveillance tests, the emergency diesel generator can be brought to rated speed and voltage in a time that is recommended by the manufacturer to minimize stress and wear. Similarly, if the generator fails to reach rated speed and voltage in the precise time required by technical specifications, the start

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[3] Additional useful information on testing and test definitions can be found in the ASME O&M Part 16, "Inservice Testing and Maintenance of Diesel Drives at Nuclear Power Plants." Copies can be obtained by contacting the American Society of Mechanical Engineers (ASME), United Engineering Center, 345 East 47th Street, New York, NY 10017.

[4] These definitions are taken from Appendix D (Rev. 1, May 2, 1990) to NUMARC-8700.

attempt is not considered a failure if the test demonstrated that the generator would start and run in an emergency.) See "Exceptions" below. Any condition identified in the course of maintenance inspections (with the emergency diesel generator in the standby mode) that would definitely have resulted in a start failure if a demand had occurred should be counted as a valid start demand and failure.

Load-run demands: To be valid, the load-run attempt must follow a successful start and meet one of the following criteria. See "Exceptions" below.

- o A load-run of any duration that results from a real (e.g., not a test) automatic or manual signal.
- o A load-run test to satisfy the plant's load and duration test specifications.
- o Other operations (e.g., special tests) in which the emergency diesel generator is planned to run for at least 1 hour with at least 50 percent of design load.

Load-run failures: A load-run failure should be counted when the emergency diesel generator starts but does not pick up load and run successfully. Any failure during a valid load-run demand should be counted. See "Exceptions" below. (For monthly surveillance tests, the emergency diesel generator can be loaded at a rate that is recommended by the manufacturer to minimize stress and wear. Similarly, if the generator fails to load in the precise time required by technical specifications, the load-run attempt is not considered a failure if the test demonstrated that the generator would load and run in an emergency.) Any condition identified in the course of maintenance inspections (with the emergency diesel generator in the standby mode) that definitely would have resulted in a load-run failure if a demand had occurred should be counted as a valid load-run demand and failure.

Exceptions: Unsuccessful attempts to start or load-run should not be counted as valid demands or failures when they can be definitely attributed to any of the following:

- o Spurious operation of a trip that would be bypassed in the emergency operation mode (e.g., high cooling water temperature trip).
- o Malfunction of equipment that is not required to operate during the emergency operating mode (e.g., synchronizing circuitry).

- Intentional termination of the test because of alarmed or observed abnormal conditions (e.g., small water or oil leaks) that would not have ultimately resulted in significant emergency generator damage or failure.

- Component malfunctions or operating errors that did not prevent the emergency diesel generator from being restarted and brought to load within a few minutes (i.e., without corrective maintenance or significant problem diagnosis).

- A failure to start because a portion of the starting system was disabled for test purposes if followed by a successful start with the starting system in its normal alignment.

Each emergency diesel generator failure that results in the emergency diesel generator being declared inoperable should be counted as one demand and one failure. Exploratory tests during corrective maintenance and the successful test that is run following repair (or preventive maintenance) to verify operability should not be counted as demands or failures when the emergency diesel generator has not been declared operable again.

2.2 Test Descriptions

The following test descriptions are to be used with Regulatory Positions 3 and 4 (see also Regulatory Positions 1.5 and 2.3). Table 1 describes the sequence of qualification and surveillance testing. There should be detailed procedures for each test described here. The procedures should identify special arrangements or changes in normal system configuration that must be made to put the emergency diesel generator under test. Jumpers and other nonstandard configurations or arrangements should not be used subsequent to initial equipment startup testing.

2.2.1 Start Test: Demonstrate proper startup from standby conditions, and verify that the required design voltage and frequency is attained. For these tests, the emergency diesel generator can be slow-started and reach rated speed on a prescribed schedule that is selected to minimize stress and wear.

2.2.2 Load-Run Test: Demonstrate 90 to 100 percent of the continuous rating of the emergency diesel generator, for an interval of not less than 1 hour and until temperature equilibrium has been attained. This test may be accomplished by synchronizing the generator with offsite power. The loading and unloading of an emergency diesel generator during this test should be gradual and based on a prescribed schedule that is selected to minimize stress

and wear on the diesel generator.

2.2.3 Fast-Start Test: Demonstrate that each emergency diesel generator unit starts from standby conditions (if a plant normally has operating prelube and keepwarm systems, these would constitute its standby conditions), and verify that the emergency diesel generator reaches required voltage and frequency within acceptable limits and time as defined in the plant technical specifications.

2.2.4 Loss-of-Offsite-Power (LOOP) Test: Demonstrate by simulating a loss-of-offsite-power that (1) the emergency buses are deenergized and the loads are shed from the emergency buses, and (2) the emergency diesel generator starts on the autostart signal from its standby conditions, attains the required voltage and frequency and energizes permanently connected loads within acceptable limits and time, energizes the autoconnected shutdown loads through the load sequencer, and operates for greater than or equal to 5 minutes.

2.2.5 SIAS Test: Demonstrate that, on a safety injection actuation signal (SIAS), the emergency diesel generator starts on the autostart signal from its standby conditions, attains the required voltage and frequency within acceptable limits and time, and operates on standby for greater than or equal to 5 minutes.

2.2.6 Combined SIAS and LOOP Tests: Demonstrate that the emergency diesel generator can satisfactorily respond to a loss-of-offsite power (LOOP) in conjunction with SIAS in whatever sequence they might occur (e.g., LOCA followed by delayed LOOP or LOOP followed by LOCA). A simultaneous LOOP/LOCA event would be demonstrated by simulating a LOOP and SIAS and verifying that (1) the emergency buses are deenergized and loads are shed from the emergency buses, and (2) the emergency diesel generator starts on the autostart signal from its standby conditions, attains the required voltage and frequency and energizes permanently connected loads within acceptable limits and time, energizes autoconnected loads through the load sequencer, and operates for greater than or equal to 5 minutes.

2.2.7 Single-Load Rejection Test: Demonstrate the emergency diesel generator's capability to reject a loss of the largest single load and verify that the voltage and frequency requirements are met and that the unit will not trip on overspeed.

2.2.8 Full-Load Rejection Test: Demonstrate the emergency diesel generator's capability to reject a load equal to 90 to 100 percent of its continuous rating, and verify that the voltage

requirements are met and that the emergency diesel generator will not trip on overspeed.

2.2.9 Endurance and Margin Test: Demonstrate full-load carrying capability for an interval of not less than 24 hours, of which 2 hours are at a load equal to 105 to 110 percent of the continuous rating of the emergency diesel generator, and 22 hours are at a load equal to 90 to 100 percent of its continuous rating. Verify that voltage and frequency requirements are maintained.

2.2.10 Hot Restart Test: Demonstrate hot restart functional capability at full-load temperature conditions by verifying that the emergency diesel generator starts on a manual or autostart signal, attains the required voltage and frequency within acceptable limits and time, and operates for longer than 5 minutes.

2.2.11 Synchronizing Test: Demonstrate the ability to (1) synchronize the emergency diesel generator unit with offsite power while the unit is connected to the emergency load, (2) transfer this load to the offsite power, and (3) restore the emergency diesel generator to ready-to-load status.

2.2.12 Protective Trip Bypass Test: Demonstrate that all automatic emergency diesel generator trips (except engine overspeed, low lube oil pressure, and generator differential) are automatically bypassed upon a SIAS. This test may be performed in conjunction with Regulatory Positions 2.2.5 and 2.2.6.

2.2.13 Test Mode Change-Over Test: Demonstrate that with the emergency diesel generator operating in a test mode while connected to its bus, a simulated safety injection signal overrides the test mode by (1) returning the emergency diesel generator to standby operation and (2) automatically energizing the emergency loads from offsite power.

2.2.14 Redundant Unit Test: Demonstrate that, by starting and running both redundant units simultaneously, potential common failure modes that may be undetected in single emergency diesel generator unit tests do not occur.

2.3 Preoperational and Surveillance Testing

Table 1 relates preoperational and surveillance tests to the anticipated schedule for performance (e.g., preoperational, monthly surveillance, 6-month, scheduled refueling period, and 10-year testing).

All planned tests described in Regulatory Position 2.2 should be preceded by a prelube period and should be in general accordance with the manufacturer's recommendations for reducing engine wear, including cool-down operation at reduced power followed by postoperation lubrication.

2.3.1 Preoperational Testing: A preoperational test program should be implemented for all emergency diesel generator systems following assembly and installation at the site. This program should include the tests identified in Table 1.

In addition, demonstrate through a minimum of 25 valid start-and-load demands in accordance with Regulatory Positions 2.2.2 and 2.2.3 without failure on each installed emergency diesel generator unit that an acceptable level of reliability has been achieved to place the new emergency diesel generator into an operational category.

2.3.2 Surveillance Testing: After the plants are licensed (after fuel load), periodic surveillance testing of each emergency diesel generator must demonstrate continued capability and reliability of the diesel generator unit to perform its intended function. When the emergency diesel generator is declared operational in accordance with plant technical specifications, the following periodic test program should be implemented.

2.3.2.1 Monthly Testing: After completion of the emergency diesel generator unit reliability demonstration during pre-operational testing, periodic testing of emergency diesel generator units during normal plant operation should be performed. Each diesel generator should be started as described in Regulatory Position 2.2.1 and loaded as described in Regulatory Position 2.2.2 at least once in 31 days (with maximum allowable extension not to exceed 25 percent of the surveillance interval).

2.3.2.2 Six-Month (or 184 days) Testing:[5] In order to demonstrate the capability of the emergency diesel generator to start from standby and provide the necessary power to mitigate the loss-of-coolant accident coincident with loss of offsite power, once every 6 months each diesel generator should be started from standby conditions as described in Regulatory Position 2.2.3 to verify that the diesel generator reaches required voltage and frequency within acceptable limits and time as specified in the plant technical specifications. Following this test, the emergency diesel generator should be loaded as described in Regulatory

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[5] This test may be substituted for a monthly test.

Position 2.2.2. (See also Table 1.)

2.3.2.3 Refueling Outage Testing: Overall emergency diesel generator unit design capability should be demonstrated at every refueling outage by performing the tests identified in Table 1.

2.3.2.4 Ten-Year Testing: Demonstrate that the trains of standby electric power are independent once every 10 years (during a plant shutdown) or after any modifications that could affect emergency diesel generator independence, whichever is the shorter, by starting all redundant units simultaneously to help identify certain common failure modes undetected in single diesel generator unit tests. (See also Table 1.)

2.3.3 Corrective Action Testing Problem Diesel Generator: If an individual emergency diesel generator experiences four or more failures in the last 25 demands, following completion of corrective actions performed through the nuclear unit emergency diesel generator reliability program, the restored performance of the problem emergency diesel generator should be demonstrated by conducting seven consecutive failure-free start and load-run demand tests (at a frequency of no less than 24 hours and of no more than 7 days between each demand). All starts and load-run tests performed during this period should be included in the nuclear unit emergency diesel generator reliability data set so long as the emergency diesel generator is declared operable.

3. RELIABILITY GOALS AND MONITORING

Reliability goals for emergency diesel generators and their monitoring are as follows:

3.1 Reliability Goals for Station Blackout

In order to comply with 10 CFR 50.63, "Loss of All Alternating Current Power," and the guidance in Regulatory Guide 1.155, "Station Blackout," the minimum reliability should be targeted at 0.95 or 0.975 per demand for each emergency diesel generator for plants in emergency ac (EAC) Groups A, B, and C and at 0.975 per demand for each emergency diesel generator for plants in EAC Group D (see Table 2 of Regulatory Guide 1.155).

The reliability of every EDG must be monitored at least monthly to determine whether the reliability target levels selected by the licensee in determining the specified station blackout duration required by §50.63(a)(1) are being met. All data from planned and unplanned demands must be used in determining the

nuclear unit EDG reliability and will be based on the last 100 demands of all EDGs for that nuclear unit as specified in §50.63(a)(3).

3.2 Calculating EDG Reliability

Emergency diesel generator reliability calculations should be based on valid start and valid load-run demands as defined in Regulatory Position 2.1 and surveillance tests as defined in Regulatory Position 2.3. The estimation of adequate emergency diesel generator performance should be based on a reliability calculation using the surveillance test data from the last 20, 50, and 100 demands and the following calculational methodology.

The calculation of the reliability of individual emergency diesel generators is comprised of two components: (1) the start reliability and (2) the load-run reliability. Since not all emergency diesel generator demands include both start and load-run demands, data on these two reliability components should be gathered and evaluated individually and then combined. An equal number of start demands and load-run demands may not occur in the same time interval. These reliability components are defined as follows:

Start Reliability (SR) is defined as:

$$SR = \frac{\text{Number of Successful Starts}}{\text{Total Number of Valid Start Demands}}$$

Load-Run Reliability (LR) is defined as:

$$LR = \frac{\text{Number of Successful Load Runs}}{\text{Total Number of Valid Load-Run Demands}}$$

$$\text{EDG Reliability} = (SR) * (LR)$$

The above equations produce point estimates of individual emergency diesel generator reliabilities with attendant uncertainties.

In addition, the effect of EDG outage times due to cumulative maintenance activities will impact EDG availability. Resolution of the station blackout safety issue assumed a maintenance related EDG unavailability of 0.007, while current operating experience shows that the cumulative annual outage times may be much higher. Such findings indicate that that proper attention should be placed on minimizing maintenance related unavailability by scheduling EDG maintenance so as to minimize potential risks during both power

operation and during refueling outages. Therefore, cummulative maintenance outage times should be reviewed when computing EDG reliabilities.

Estimates of emergency diesel generator reliability for a nuclear unit should use individual emergency diesel generator performance data, which are then combined in a manner representative of the emergency diesel generators assigned to a specific nuclear unit. Table 2 provides guidance for combining data from individual emergency diesel generator start and load-run data to calculate the nuclear unit reliability.

3.3 Monitoring and Maintaining Emergency Diesel Generator Reliability

Monitoring of EDG performance is essential for the detection of reliability degradations at an early stage and for the verification of target levels selected for compliance with 10 CFR 50.63. Data from all planned and unplanned demands should be used to estimate the nuclear unit EDG reliability level(s). Failures encountered in the last 20, 50, and 100 demands (on a per nuclear unit basis) should be used for such estimates and identification of corrective action(s).

Estimating nuclear unit EDG reliability with a high confidence level requires a large sample size (i.e., 100 demands). Assuming planned plus unplanned demands, two years could pass at a nuclear unit with two EDGs before this sample size would be accumulated. In the meantime, the EDG reliability could have degraded below 0.95. The competing effects of detection response probability, false alarm probability and sample size (which takes time to accumulate) lead to an EDG performance tracking concept which is based on failures/demand in the last 50 and 100 demands (termed the "double trigger" approach). Although use of this double trigger provides some improvement of detection capability and reduction of false alarms without incurring a long waiting period for taking corrective action, it does not provide high confidence that EDG reliability is being maintained at an acceptable level. From the statistical point of view , the occurrence of a double trigger provides clear evidence that EDG reliability has degraded to unacceptable levels.

The following "double trigger" values were selected to minimize false alarm probability, achieve reasonable detection response probability and reduce detection time:

Nuclear Unit EDG	Early Warning	Double Trigger

Target Reliability	(Failures/Demand)	(Failures/Demand)
0.95	3/20	5/50 and 8/100
0.975	3/20	4/50 and 5/100

Monitoring of EDG performance should be based on monitoring failures and successes to start and load-run, and utilize the following criteria:

1) EARLY WARNING: If there are 3 failures within the last 20 last demands for either an individual EDG or for all EDGs assigned to a nuclear unit, this is an early indicator of potential deterioration of EDG reliability. The NRC should be notified and corrective action taken by the licensee.

2) PROBLEM DIESEL: If there are 4 failures in the last 25 demands of an EDG, this is a further indication of EDG reliability deterioration and also the ineffectiveness of the EDG maintenance program. Following corrective action this EDG should be subjected to accelerated testing to demonstrate effectiveness of maintenance actions (i.e., 7 consecutive failure free tests) discussed below.

3) DOUBLE TRIGGER: If there are 5 failures within the last 50 demands and 8 failures within the last 100 demands (nuclear unit target reliability = 0.95), or 4 failures within the last 50 demand and 5 failures within the last 100 demands (nuclear unit target reliability = 0.975), then this is clear evidence that EDG maintenance activities are not effective and that the EDG reliability level has dropped significantly below the target level. This condition is clearly non-compliance with §50.63(a) and regulatory action should be taken. The actions and reporting requirements of §50.63(a)(3)(ii)(C) should be carried out.

3.4 Problem Diesel Generator

A problem diesel generator is defined as an individual emergency diesel generator that has experienced four or more failures in the last 25 demands.

Following completion of effective corrective actions, restored performance of the problem emergency diesel generator should be demonstrated by conducting seven consecutive failure-free start and load-run demand tests per Regulatory Position 2.3.3. The monthly

surveillance test schedule should not be resumed until the seven consecutive tests are successfully completed.

This process of evaluating recent demands and taking appropriate action on the individual emergency diesel generator experiencing recurring failures is a key element in providing reasonable assurance that EDG maintenance activities are being effective.

3.5 Recovery from a Double Trigger

Recovery from the "double trigger" condition should be based on an accelerated surveillance testing frequency for those EDGs that have experienced failures. This EDG test frequency of no more than 7 days, but not less than 24 hours, should be maintained until failures per demand have returned to within the double trigger bounds (ie. 4/50 and 7/100 for a 0.95 target, 3/50 and 4/100 for the 0.975 target) on a nuclear unit basis.

4. RECORDKEEPING[6]

Guidance from Section 7.5.2, "Records and Analysis," of IEEE Std 387-1984 should be supplemented as follows:

Licensees should retain the following information related to EDG failures to start and load-run that occur during all planned and unplanned demands:

a. Data on valid demands and failures that are used to calculate start and load-run nuclear unit EDG reliability.

b. Corrective actions taken in response to individual EDG failures.

c. A description of any EDG reliability program improvements implemented following occurrence of a "double trigger" and the schedule of planned and in-progress EDG maintenance improvements.

5. REPORTING CRITERIA

When reporting emergency diesel generator failures, all plants should conform with the provisions of 10 CFR 50.63(a)(3), 10 CFR 50.72, 10 CFR 50.73, 10 CFR Part 21, plant technical

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[6] Licensees should also retain data relevant to the fast-start tests required by the technical specifications.

specifications, and other current NRC reporting regulations.

These reports should contain the following information:

a. The calculated nuclear unit and individual EDG reliability based on the last 20, 50, and 100 planned and unplanned demands using the methodology described in Regulatory Position 3.2.

b. A description of the failures, underlying causes, and actions taken for failures that have occurred in the last 20, 50, and 100 planned and unplanned demands. The reported failures should also include any "non-valid" failures experienced by the EDGs.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plans for using this regulatory guide.

Except in those cases in which an applicant proposes an acceptable alternative method for complying with the specified portions of the Commission's regulations, the methods described in Regulatory Positions 1 and 2 of this guide will be used by the NRC staff in evaluating the selection, design, qualification, and testing of diesel generator units used as onsite electric power systems for the following nuclear power plants:

1. Plants for which the construction permit is issued after January 31, 1991.

2. Plants for which the operating license application is docketed after July 31, 1991.

3. Plants for which the licensee commits to the provisions of this guide.

The NRC staff intends to use Regulatory Positions 3, 4, and 5 of this regulatory guide to monitor emergency diesel generator reliability levels for compliance with 10 CFR 50.63(ammended).This guide will become effective six months after the rule becomes effective.

Table 1. Preoperational and Surveillance Testing[1]

Tests Described in Regulatory Position 2.2	Preoperational Test Program	Monthly Surveillance Tests	6-Month Tests	Refueling Outage	10-Year Tests
2.2.1 Start Test		X			
2.2.2 Load-Run Test	X[2]	X	X[3]		
2.2.3 Fast-Start Test	X[2]		X[3]	X	
2.2.4 Loss-of-Offsite-Power (LOOP) Test	X			X	
2.2.5 SIAS Test	X			X	
2.2.6 Combined SIAS and LOOP Tests	X			X	
2.2.7 Single-Load Rejection Test	X			X	
2.2.8 Full-Load Rejection Test	X			X	
2.2.9 Endurance and Margin Test	X			X	
2.2.10 Hot Restart Test	X			X	
2.2.11 Synchronizing Test	X			X	
2.2.12 Protective-Trip Bypass Test	X			X	
2.2.13 Test Mode Change-Over Test	X			X	
2.2.14 Redundant Unit Test	X				X

[1]Technical specification requirements take precedence to this table.

[2]Utilities should retain data for fast starts required by technical specifications.

[3]This test may be Substituted for a monthly test.

TABLE 2 Combining Individual EDG Failure Data

EDG Configuration	Method for Combining
2, 3, 4 EDGs dedicated to nuclear unit	Use combined failure experience of all EDGs.
2, 3, 4 EDGs shared between units	Use combined failure experience of all EDGs for all units.
1 dedicated EDG at each unit and 1 shared between units	Each unit uses the combined failure experience of its dedicated EDGs and the shared EDG.
2 dedicated EDGs at each unit and 1 shared between units	Each unit uses the combined failure experience of its dedicated EDGs and the shared EDG.
2 dedicated EDGs and 1 HPCS EDG or diverse EDGs within the same unit	Use the combined failure experience of similar EDGs and separately consider the failure experience of different EDGs.