EMERGENCY DIESEL GENERATOR TECHNICAL SPECIFICATION SURVEILLANCE REQUIREMENTS REGARDING ENDURANCE AND MARGIN TESTING

CORNERSTONE: MITIGATING SYSTEMS

2515/176-01 OBJECTIVES

The objective of this temporary instruction (TI) is to gather information to assess the adequacy of nuclear power plant emergency diesel generator (EDG) endurance and margin testing as prescribed in plant-specific technical specifications (TS).

2515/176-02 APPLICABILITY

This TI applies to all operating nuclear power reactor licensees that use EDGs as the onsite standby power supply. This TI applies only to EDGs that are tested in accordance with the TS surveillance requirements (SRs).

2515/176-03 BACKGROUND

On August 29, 2005, staff of the U.S. Nuclear Regulatory Commission (NRC) Region III office submitted a task interface agreement (TIA) to request assistance from the Office of Nuclear Reactor Regulation (NRR) in assessing the adequacy of the EDG testing procedure at the Dresden Nuclear Power Station (DNPS). In response to the TIA, the NRR staff concluded that the EDG endurance test performed by DNPS was not consistent with the intent of the TS SR for establishing EDG operability because the loading of the EDGs during testing did not envelop the predicted design-basis event (DBE) loading. Inspectors have subsequently identified this inconsistency at other sites. The NRR staff has also identified issues related to test loading requirements, peak design-basis loading values and durations, and EDG ratings when reviewing license amendment requests to correct the endurance and margin testing acceptance criteria. Therefore, the NRR staff is issuing this TI to assess the extent of these issues and to evaluate the adequacy of EDG testing as prescribed in plant-specific TS and design bases.

The EDG endurance and margin test (Standard Technical Specifications (STS) SR 3.8.1.14, NUREGs 1430-1434) is normally performed every 18 to 24 months to demonstrate the ability of the EDG to handle the predicted accident loads with a single active failure of a redundant EDG. The EDG loading is generally designed for a concurrent loss of offsite power and loss-of-coolant accident (LOOP/LOCA). The

concurrent LOOP and large-break (LB) LOCA loading profile is generally high; however, at some sites, the calculated LOOP coincident with a small-break (SB) LOCA or a main steamline break (MSLB) load values were greater than the LOOP/LBLOCA load values.

STS SR 3.8.1.14 specifies that the EDGs be operated for 24 hours, 2 hours of which will be at 105 to 110 percent of the continuous rating, with the remaining 22 hours at 90 to 100 percent of the continuous rating. EDGs are rated at different power (kilowatt (kW)) levels for certain durations. These are generally referred to as the continuous rating and the short-time rating, as defined in Institute of Electrical and Electronics Engineers (IEEE) Standard 387, "IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power supplies for Nuclear Power Generating Stations." However, some nuclear power plants have EDGs that have 2000-hour, 4-hour, 2-hour, and 0.5-hour ratings and may have been allowed to operate or test at these ratings depending on when the plant was licensed.

The rating of an EDG can be affected (derated) by factors such as EDG loading, engine coolant outlet temperature, or air intake (combustion air) temperature. In addition, variations in frequency and voltage and the accuracy of the EDG governor and voltage regulator systems can affect the EDG loading. Licensees should consider these factors in their EDG loading calculations and testing acceptance criteria, especially if the proposed testing and/or design-basis loading profile is approaching the EDG rating limits. NRC inspectors have identified instances in which the EDG loading calculations failed to account for the increased electrical load resulting from EDG operation at the maximum frequency allowed by the TS. The operation of rotating equipment at higher frequency and voltage could result in increased EDG loading under accident conditions. Other factors that could impact EDG loading include motor efficiency, cable losses, and pump run-out conditions. The STS also specify that the endurance test be performed at the design-load power factor if grid conditions allow it. The power factor requirement is meant to simulate the reactive loading of the EDG during a DBE.

The NRC staff has issued guidance for EDG design and testing in Safety Guide 9, "Selection of Diesel Generator Set Capacity For Standby Power Supplies," Regulatory Guide (RG) 1.108, "Periodic Testing of Diesel Generator Units Used As Onsite Electric Power Systems at Nuclear Power Plants," and RG 1.9 (Revisions 1 through 4), currently titled, "Application and Testing of Safety-Related Diesel Generators In Nuclear Power Plants." The NRC withdrew RG 1.108 with the issuance of Revision 3 of RG 1.9 in July 1993. RG 1.9 indicates that IEEE Standard 387 is acceptable for meeting the requirements of the principal design criteria, qualification testing, and periodic testing of EDG units as onsite electric power systems subject to the regulatory positions and exceptions stated in the RG. NRC Information Notice (IN) 1991-13, "Inadequate Testing of Emergency Diesel Generators (EDGs)," and IN 2008-02, "Findings Identified During Component Design Bases Inspections," provide additional information related to the adequacy of EDG design and testing.

2515/176-04 INSPECTION REQUIREMENTS

04.01 Requirement. Complete the worksheet located in Attachment 1 for every EDG used as an onsite standby power supply.

Guidance. Use the following guidance when answering the questions in Attachment 1. Note that the questions apply to every EDG covered by the TS.

a. Question 1. Request the licensee to provide the make and model of the EDG unit, the governor system, and the voltage regulator system. Also request the licensee to provide the EDG ratings. Verify that this information is consistent with the EDG vendor/manufacturer's specifications. Confirm that this information has been documented in the updated final safety analysis report (UFSAR), and document any discrepancies. In addition, document whether or not the UFSAR restricts the design loading to within a particular rating. Note that manufacturers will typically specify additional maintenance requirements when the EDGs are operated at their rating limits. Verify that the licensee's procedures take into account this information, if applicable.

b. Question 2. Obtain the most recent revision of the licensee's TS. The EDG SRs are typically found in Chapters 3.8 or 4.8 of the licensee's TS. Use the following link to the STS and STS Bases to obtain more information about the EDG endurance run surveillance requirement, STS SR 3.8.1.14:

   http://www.nrc.gov/reactors/operating/licensing/techspecs/current-approved-sts.html.

   Record the kW values and/or range of values provided in the licensee's TS for each time interval of the endurance and margin test. In addition, review the licensee's procedure for implementing the TS SR or the procedure used to verify by testing that the EDGs can achieve design loading. Verify that the procedure has the same kW values and range of kW values as stated in the TS. If the procedure requirements differ from the TS requirements, also provide the kW values and/or range of values provided in the procedure for each time interval of the endurance and margin test.

   Note that EDG mission times are typically around 30 days, and a 24-hour test provides assurance that an EDG can meet its mission time. The endurance and margin test duration is typically 24 hours, but the NRC approved some sites to perform the test for 8 hours (Beaver Valley, Cooper, DC Cook, Indian Point, FitzPatrick, and Monticello). For plants that do not have a test equivalent to the STS endurance and margin test (i.e., a 24-hour endurance run), provide a comment in this section of the worksheet and describe the testing requirements (loads and durations) for the load run test that is performed. Use this section to document plants with 8-hour and 1-hour endurance run SRs and plants with no endurance run SRs.

c. Question 3. To answer Question 3a, request the licensee to provide the calculated or expected DBE load profile (usually a graph or table showing EDG loading versus time) expected of each EDG. Licensees should have this information for a LOOP/LBLOCA, LOOP/SBLOCA, and a LOOP/MSLB worst case loading with a single failure of one EDG. Find the largest or peak DBE kW load value in the profile and compare this value to the continuous rating load value of each EDG.

To answer Question 3b, ensure that the licensee's EDG loading calculation accounts for the factors (such as derating and frequency/voltage variations) mentioned in Section 03 of this TI to verify that the calculated expected load profile is indeed the worst case load profile. Request the licensee staff to demonstrate how variations in frequency and/or voltage were considered in the calculated EDG load when the EDG is operating in isochronous mode (i.e., not paralleled to the grid). The TS generally provide a range of allowable values of steady-state frequency and voltage to envelop both isochronous and droop modes of operation. The NRC staff has identified instances in which the EDG kW loading was affected by operation at the high end of the allowed frequency band, which becomes important when the EDG loading is close to the EDG rating. In isochronous mode (actual condition when carrying accident loads), the EDG steady-state frequency and voltage variation will depend upon the EDG governor and voltage regulator setting and accuracy.

d. Question 4. Using the DBE load profile described above, compare the DBE load profile to the load profiles specified in either the licensee's TS SR and associated procedure for the EDG endurance run or in a procedure used to verify by testing that the EDGs can achieve design loading. Verify that the DBE load values and durations of those load values are within the values and durations of the load values specified in either the licensee's TS SR and its associated procedure or in a procedure used to verify by testing that the EDGs can achieve design loading. Verify that the DBE loads are not expected to increase above the testing values after the initial 24 (or 8) hours after initiation of a LOOP/LOCA. In addition, review the results of the past three surveillance tests for each EDG to verify that the licensee's tests demonstrate the design requirements.

For plants that do not have a test equivalent to the STS endurance and margin test, as noted in Section 2 of the worksheet, indicate whether the test that is performed envelops the peak DBE load value and duration of the peak load value.

e. Questions 5 and 6. Reference the licensee's endurance run TS SR and the procedures used to implement this SR (or the procedure used for demonstrating that the EDG can achieve design loading). The power factor value can usually be found in the NOTES section of the SR. The licensee's EDG loading calculation should identify the basis for the power factor limit. Review the results of the last three TS surveillance tests for each EDG to verify that the required

power factor value was obtained (or that justification was provided if it could not be obtained) during the tests. If the power factor limit specified in the TS could not be achieved because of grid conditions, verify that the licensee's procedures provide direction for establishing and documenting the revised power factor limit to be tested.

f. Question 7. Request the licensee to explain how the operators implement the EDG testing procedure with respect to declaring the EDG (in)operable while the EDG is being tested. EDGs not capable of and/or designed for automatically transferring to isochronous mode of operation may have to be declared inoperable for monthly and endurance testing. Licensees should have supporting analysis for this mode of operation. In addition, obtain information from the licensee regarding the EDG response to a LOOP or grid voltage fluctuation that occurs during an endurance test.

g. Question 8. Request the licensee to provide a history of all EDG run failures (i.e., failures that occur after the EDG output breaker closes) that occurred during any EDG operation including, but not limited to, the endurance test or any other TS SR test and EDG operation in response to an actual loss of power to the safety bus. Identify each failure separately in the worksheet or in a separate attachment. Briefly describe the failures, the circumstances in which they occurred, their root causes, and at what point during the test they occurred (e.g., the failure occurred 9 hours into the 24-hour run). This information should be available in the licensee's corrective action program and maintenance rule databases. Failures that are searchable in an electronic database are within the scope of this TI.

h. Section 9. Provide any additional clarifications or comments. Use additional pages if necessary. Also note any operational or vendor constraints and/or recommendations for testing the EDGs at nameplate conditions.

2515/176-05 REPORTING REQUIREMENTS

The regional coordinators should submit the responses to the inspection requirements specified in Section 04, including the completed worksheets, electronically to George Wilson via email (george.wilson@nrc.gov no later than August 31, 2008. If necessary, the responses can also be mailed to the attention of George Wilson, 11555 Rockville Pike, Mail Stop O-9E3, Rockville, MD 20852-2746, no later than August 31, 2008. Inspectors may complete the worksheets as an Excel spreadsheet or a table within a Word document.

Inspectors should be able to briefly describe the areas reviewed (i.e., provide a summary documenting that the inspection was completed) and any findings in Section 4OA5, "Other," of the resident inspector's quarterly integrated inspection report. The completed worksheets are not to be included in the inspection report.

Any findings identified during this inspection will be processed and documented in accordance with NRC Inspection Manual Chapter (IMC) 0612, "Power Reactor Inspection Reports." Significance of inspection findings should be evaluated in accordance with applicable appendices of IMC 0609, "Significance Determination Process." Any noncompliance resulting from this inspection will be evaluated and documented in accordance with the NRC Enforcement Policy (NUREG-1600) and the NRC Enforcement Manual.

2515/176-06 COMPLETION SCHEDULE

This TI will be completed no later than December 31, 2008.

2515/176-07 EXPIRATION

This TI will expire on August 31, 2009.

2515/176-08 CONTACTS

For technical support regarding the performance of this TI and emergent issues, contact George Wilson (NRR/DE/EEEB, Branch Chief) at 301-415-1711 or george.wilson@nrc.gov at 301-415-0489. For administrative, reporting, or documentation questions, contact Stephen Vaughn at 301-415-3640 or stephen.vaughn@nrc.gov.

2515/176-09 STATSITICAL DATA REPORTING

All direct inspection effort expended on this TI is to be charged to 2515/176 for reporting by the Human Resources Management System with an IPE code of TI.

2515/176-10 ORIGINATING ORGANIZATION INFORMATION

10.01 Organizational Responsibility. This TI was initiated by the Office of Nuclear Reactor Regulation, Division of Engineering, Electrical Engineering Branch (NRR/DE/EEEB).

10.02 Resource Estimate. The estimated effort to perform this survey is estimated to be 20 to 40 hours per site.

10.03 Training. No specialized training is needed to perform inspection requirements in this TI beyond basic training for inspectors (specified in IMC 1245, "Inspector Qualifications"). However, if technical support is needed during the inspection, contact the EEEB technical contact stated in Section 08 of this TI.

2515/176-11 REFERENCES

Standard Technical Specifications Surveillance Requirement 3.8.1.14 (NUREG 1430, NUREG-1431, NUREG-1432, NUREG-1433, and NUREG-1434).

IEEE Standard 387, “IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power supplies for Nuclear Power Generating Stations,” 1977, 1984, and 1995.

Safety Guide 9, “Selection of Diesel Generator Set Capacity For Standby Power Supplies,” March 1971.

NRC Regulatory Guide 1.108, “Periodic Testing of Diesel Generator Units Used As Onsite Electric Power Systems at Nuclear Power Plants,” Revision 1, August 1977 (withdrawn).

NRC Regulatory Guide 1.9, “Application and Testing of Safety-Related Diesel Generators In Nuclear Power Plants,” Revision 1 (November 1978), Revision 2 (December 1979), Revision 3 (July 1993), and Revision 4 (March 2007).

NRC Information Notice 1991-13, “Inadequate Testing of Emergency Diesel Generators (EDGs),” March 4, 1991.

NRC Information Notice 2008-02, “Findings Identified During Component Design Bases Inspections,” March 19, 2008.

Attachment 1: Worksheet

PLANT NAME:	UNIT #: EDG ID#:	UNIT #: EDG ID#:	UNIT #: EDG ID#:	UNIT #: EDG ID#:
1a. Provide the name of the manufacturer/make and model for the following: a. EDG unit b. Governor system c. Voltage regulator system	(a) (b) (c)	(a) (b) (c)	(a) (b) (c)	(a) (b) (c)
1b. Provide all of the EDG ratings, as available, such as the continuous, 2000-hour, short-time/term, 2-hour, and 0.5-hour ratings (kilovolt-ampere (kVA), kW, and power factor (PF)). Verify that these ratings are consistent with the EDG vendor/manufacturer's specifications. Note any constraints.				
2. Provide the TS SR loading requirements, in kW, for the endurance run SR (STS SR 3.8.1.14): a. Initial [2] hours of the endurance run b. Remaining hours of the endurance run Provide the licensee's procedural requirements for EDG loading if they differ from the TS SR loading requirements.	(a) (b)	(a) (b)	(a) (b)	(a) (b)
3a. Does the EDG continuous rating envelop the peak design load (kW) expected during a DBE?				
3b. Did the licensee account for the worst case voltage and frequency values to determine the worst case loading in the EDG loading design calculation?				
4. Do the load profiles contained in the TS SR (and in the procedures for verifying that the EDGs can achieve design loading) envelop the DBE load profile? If they do not, please clarify in this section and/or provide the load profile(s) to the NRR contact.				

PLANT NAME:	UNIT #: EDG ID#:	UNIT #: EDG ID#:	UNIT #: EDG ID#:	UNIT #: EDG ID#:
5. Does the licensee's endurance run TS SR (and/or procedure) require testing the EDG to a power factor value? (If it does not, proceed to #7.)				
6a. Does the TS SR power factor value envelop the worst case design load power factor value expected during a DBE? If it does not, please clarify in this section.				
6b. Does the licensee's procedure for testing the power factor provide directions for determining whether the grid conditions will allow the power factor limit to be met?				
6c. If grid conditions do not allow the power factor limit to be met, does the licensee's procedure for testing the power factor limit require that the licensee document (1) the justification for why the grid conditions did not allow the power factor limit to be met, and (2) the basis for the power factor value that was tested?				
7. (a) Is the endurance run performed with the EDG aligned parallel to the grid, regardless of the plant mode? (b) If yes, is the licensee declaring the EDG inoperable when it is run parallel to the grid? (c) If the licensee is not declaring the EDG inoperable in parallel mode, does the licensee have the necessary analysis to prove that the EDG will not trip and return to standby mode if the EDG is subjected to transients caused by a LOOP or faults in the upstream system? (d) What is the response of the EDG to a LOOP or grid voltage fluctuation that occurs during an endurance test run?	(a) (b) (c) (d)	(a) (b) (c) (d)	(a) (b) (c) (d)	(a) (b) (c) (d)
8. Briefly describe all run failures that have occurred during the endurance tests, EDG operation in response to an actual loss of power to the safety bus, and other TS surveillance tests. For each failure, document the date of the failure, the root cause, and the time at which the problem occurred during the test or EDG operation. Use a separate sheet if necessary.				
9. Provide any additional clarifications or comments. Use additional pages if necessary.				

Attachment 2

Revision History for TI 2515/176

Commitment Tracking Number	Issue Date	Description of Change	Training Needed	Training Completion Date	Comment Resolution Accession Number
N/A	05/16/08 CN 08-015	Implement the close-out actions of Issue For Resolution (IFR) 2006-020 (ML071420096).	N/A	N/A	ML081070115