

July 11, 2007

MEMORANDUM TO: Cynthia D. Pederson, Director
Division of Reactor Safety
Region III

FROM: Michael J. Case, Director **/RA by HNieh for MCase/**
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

SUBJECT: STAFF RESPONSE TO TIA 2005-009 REGARDING EMERGENCY
DIESEL GENERATOR TESTING, REVISION 1 (TAC NO. MD3715)

On March 1, 2006 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML060340047), the Office of Nuclear Reactor Regulation (NRR) staff issued its response to Task Interface Agreement (TIA) 2005-009 regarding emergency diesel generator (EDG) testing at Dresden Nuclear Power Station (Dresden or DNPS). Subsequently, the NRR staff raised a concern that the NRR position in this TIA response could have backfit implications. Therefore, the NRR staff reopened this issue to evaluate the technical justification of the position and to perform a backfit determination. In performing backfit determinations, the NRR staff follows the guidance in NRR Office Instruction LIC-202, Revision 1, "Managing Plant-Specific Backfits and 50.54(f) Information Requests" (ADAMS Accession No. ML061720504).

The NRR staff positions regarding the adequacy of EDG testing at Dresden were documented in the response to TIA 2005-009 as follows:

1. The current EDG endurance test performed by DNPS, at 2340 to 2600 kiloWatts (kW) for 22 hours and 2730 to 2860 kW for 2 hours, is not consistent with the intent of the technical specification (TS) surveillance requirement (SR) for establishing the operability of the EDGs. The current test does not envelop the actual power demand requirements for the EDG during design-basis conditions. The licensee should submit an amendment request to modify the non-conservative TS SR.
2. The licensee's procedures for the 24-hour EDG endurance and margin TS SR require testing at the power factor limit for a duration of 10 minutes. The test is not consistent with the intent of the TS SR for establishing operability of the EDG because it does not test to the worst-case power factor for design-basis conditions for 24 hours. Therefore, the licensee's current TS SR at DNPS is non-conservative in that it does not demonstrate performance of the EDG under worst-case loading and power factor for design-basis conditions.

The NRR staff concludes that the first staff position in the TIA response is technically justified. However, during a telephone conference with the U.S. Nuclear Regulatory Commission (NRC) staff on April 26, 2007, the licensee stated that the EDG loading was recalculated and was within the continuous rating of the EDGs as of April 4, 2007. The licensee provided the NRC staff with the Dresden EDG testing procedure (ADAMS Accession No. ML071570512) on

April 27, 2007, and the EDG loading calculation (ADAMS Accession No. ML071570498) on May 3, 2007. The calculation states that if a future calculation revision shows the loading to exceed the 2600 kW continuous rating, a Title 10 of the *Code of Federal Regulations* (10 CFR) 50.59 safety evaluation would be performed to assess the impact on the Dresden design and licensing basis.

The licensee adjusted the EDG loading so that the TS SR was now conservative before the NRR staff concluded its backfit determination. Appendix B of LIC-202 states that the backfit determination does not apply to a modification or action proposed by a licensee; therefore, the NRR staff concludes that a formal backfit determination is no longer required.

For the second staff position, the NRR staff concludes that it is technically justified, is consistent with previous NRC staff positions, and does not require a backfit determination. However, the NRR staff revised the TIA response in order to clarify that the licensee's procedural requirement of testing to the power factor limit for 10 minutes did not meet the intent of the EDG endurance and margin TS SR.

The NRR staff's revised TIA response is enclosed.

Docket Nos: 50-237 and 50-249

Enclosure: As stated

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301-415-1842

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REVISION 1 OF THE RESPONSE TO TASK INTERFACE AGREEMENT (TIA) 2005-009

EMERGENCY DIESEL GENERATOR SURVEILLANCE TESTING

AT DRESDEN NUCLEAR POWER STATION

1.0 INTRODUCTION

On August 12, 2005, the NRC Region III (RIII) Division of Reactor Safety staff completed a safety system design and performance capability baseline inspection (Agencywide Documents Access and Management System (ADAMS) Accession No. ML052590556) at Dresden Nuclear Power Station (DNPS). The emergency diesel generators (EDGs) were chosen as the system to be reviewed. During the inspection, the inspectors identified concerns related to the level of compliance with DNPS Technical Specification (TS) Surveillance Requirement (SR) 3.8.1.15 (related to 24-hour endurance testing) and the associated TS Bases.

In a memorandum from C. Pederson to C. Haney dated August 29, 2005 (ADAMS Accession No. ML052580444), the RIII staff requested that the Office of Nuclear Reactor Regulation (NRR) staff resolve the following issues associated with the licensing and conformance with DNPS TS SR 3.8.1.15:

1. EDG surveillance testing, while potentially in compliance with licensee commitments and respective TS, does not envelop the predicted loss-of-offsite power (LOOP) coincident with a loss-of-coolant accident (LOCA) load requirements. This concern relates to the adequacy of current TS SRs.

Specifically, the RIII staff requested an answer to the following question:

Does the current endurance test at 2340 to 2600 kiloWatts (kW) for 24 hours provide reasonable assurance that the EDGs will be able to carry 2851 kW for an extended period during a design-basis accident, or are the values within the TS SR non-conservative?

2. EDG surveillance procedures require testing at a power factor for only 10 minutes of the 24-hour endurance test.

Specifically, the RIII staff requested an answer to the following question:

Does the licensee's test approach of loading the EDG to 1550 - 1600 kilovolt ampere reactive (kVAR) for 10 minutes meet the supporting regulatory analysis and intent of the TS requirements?

ENCLOSURE

The NRR staff provided its response to these questions on March 1, 2006 (ADAMS Accession No. ML060340047). This revision of the TIA response incorporates further comments received from the NRR staff.

2.0 EVALUATION

In response to the questions asked in TIA 2005-009, the NRR staff compared the DNPS TS SR 3.8.1.15 to SR 3.8.1.14 of the Standard TSs (STS), NUREG-1433, Rev. 2, "Standard Technical Specifications General Electric Plants, BWR/4." The NRR staff also compared the sizing and testing of the DNPS EDGs to the recommendations of Revision 3 of NRC Regulatory Guide (RG) 1.9, "Selection, Design, Qualification, and Testing of Emergency Diesel Generator Units Used as Class 1E Onsite Electric Power Systems at Nuclear Power Plants," dated July 1993.

Question 1

Does the current endurance test at 2340 to 2600 kW for 24 hours provide reasonable assurance that the EDGs will be able to carry 2851 kW for an extended period during a design-basis accident, or are the values within the TS SR non-conservative?

This question pertains to the EDG kW rating versus the EDG loading and the TS SR testing period for EDG endurance testing. The pertinent information relating to EDG rating and the TS SR is as follows:

DNPS EDG Rating and Loading (kW):

	EDG Ratings		EDG Calculated Loading	
	Continuous	Ten Percent Overload - 2000 Hr	Short-term (less than 10 minutes)	Long-term (greater than 10 minutes)
kW	2600	2860	2228	2851
pf	0.8	0.8	0.88	0.88

DNPS TS SR 3.8.1.15 requires the following:

Verify each DG [diesel generator] operating within the power factor limit operates for 24-hours:

- a. For ≥ 2 hours loaded ≥ 2730 kW and ≤ 2860 kW (105 percent to 110 percent of continuous rating); and
- b. For the remaining hours of the test loaded ≥ 2340 kW and ≤ 2600 kW (90 percent to 100 percent of continuous rating).

Revision 3 of RG 1.9, Section C.2.2.9 (Endurance and Margin Test) states:

Demonstrate full-load carrying capability at a power factor between 0.8 and 0.9 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.

Revision 3 of RG 1.9, Section C.1.3 also states:

At the operating license stage of review, the predicted loads should not exceed the continuous rating of the diesel generator unit.

The STS SR 3.8.1.14 requires every [18 months]:

Verify each DG operates for ≥ 24 hours:

- a. For $\geq [2]$ hours loaded $\geq [3100]$ kW and $\leq [3400]$ kW and
- b. For the remaining hours of the test loaded $\geq [2850]$ kW and $\leq [3150]$ kW.

Technical Bases

The purpose of the EDG endurance and margin test is to demonstrate that each machine is in operational readiness to assume the design-basis accident loads even when the redundant EDG has failed. A test of 24 hours is considered to be a reasonable duration to ascertain if the EDG capability continues to remain intact for a potentially long-term operation much greater than 24 hours to bring the plant to a safe shutdown following a design-basis accident.

The tests performed should most closely simulate the actual stresses on the machine to gain confidence in its readiness as stated in Regulatory Position C.1.5 of Revision 3 of RG 1.9. The test challenges the fuel system's ability to supply fuel in order to keep up with the maximum and varying load demand and the voltage regulator/excitation system's ability to produce sufficient magnetic flux to maintain the terminal voltage within acceptable limits. During this test, the engine is expected to continue to supply the motive power without exceeding operational limits on the support systems. This can be achieved only when the diesel engine is loaded to its expected design-basis loading conditions and when the generator is producing sufficient voltage and current that reflect design-basis accident loading.

The mechanical systems generally reach steady-state conditions in two hours, but the capability to endure a long period of operation can be confirmed only through a test of a longer duration. The electrical stresses reach the maximum only when maximum current is drawn from the generator to supply full load and when reactive power compensates for loads with a lagging power factor. The lagging power factor increases the load current on the generator which then demands more work from the excitation system to compensate for the increase voltage drop across the generator's internal impedance. Operation at these conditions heats the armature windings, the field windings, and the stator core which demands maximum output from the support systems. If these capabilities are not periodically demonstrated, the technical bases for declaring the EDG to be operable lack credibility.

Technical Assessment

The EDG LOOP-LOCA long-term loading at DNPS was 2851 kW. The licensee's test practice of approaching a loading of 2860 kW for approximately two hours did not meet the intent of the SR. Although the test practice appears to be consistent with RG 1.9, the provisions of RG 1.9 are applicable if the actual loads needed during design-basis conditions are such that in the first two hours, the loading requires entry into the short-time rating and then the loading decreases to a value within the continuous rating. The NRR staff's review of EDG loading at several nuclear power plants has shown that an initial spike in the EDG loading exists for the first two hours of a design-basis event, but the steady-state emergency core cooling (ECCS) loading decreases to a value within the continuous rating of the EDG. If the long-term accident loads require the short-term loading capability of the EDG, the endurance test needs to reflect such loading conditions to verify EDG capability.

The NRC staff has clarified this position in the "Discussion" section of Revision 3 of RG 1.9, which states, "... the sum of the total loads at the operating license stage should not exceed the continuous rating of the emergency diesel generator." In addition, Revision 3 of RG 1.9, Regulatory Position C.2.2.9, "Endurance and Margin Test," states, in part, that EDG surveillance testing should be conducted for two hours at a load equal to 105 to 110 percent of the continuous rating. Testing to 105 to 110 percent of the continuous rating demonstrates margin in the EDG's capability to meet design basis power demands for an EDG that is sized to meet Regulatory Position C.2.2.9 of Revision 3 of RG 1.9. The licensee's EDG endurance and margin test would demonstrate margin only when the actual accident loading is less than the tested limits.

Demonstration of margin for the EDG is essential in the accident mitigation mode of the ECCS operation because of the following reasons:

- The current drawn by motors under pump run-out conditions (supply flow against an existing pipe break) could be higher than the calculated values using the typical pump curves.
- The motor characteristics may have changed due to rewinding, plant modifications, or aging.
- The flow conditions would be different if only one EDG is operating and therefore, the current consumption could be higher.
- The intake air temperature for the diesel engine could influence the maximum output of the engine when the environmental temperature is higher.

The DNPS EDG 2000-hour rating is 2860 kW, whereas the worst-case LOOP-LOCA load was 2851 kW. Although the 2000-hour rating bounds the worst-case accident load, the test load profile indicated below does not bound the design-basis power demands. Therefore, the licensee's practice to test EDGs at the values indicated below, albeit in compliance with the TS SRs, was non-conservative:

- a. For ≥ 2 hours loaded ≥ 2730 kW and ≤ 2860 kW and
- b. For the remaining hours of the test loaded ≥ 2340 kW and ≤ 2600 kW.

However, during a telephone conference with the U.S. Nuclear Regulatory Commission (NRC) staff on April 26, 2007, the licensee stated that the EDG loading was recalculated and was within the continuous rating of the EDGs as of April 4, 2007. The licensee provided the NRC staff with the Dresden EDG testing procedure (ADAMS Accession No. ML071570512) on April 27, 2007, and the EDG loading calculation (ADAMS Accession No. ML071570498) on May 3, 2007. The calculation states that if a future calculation revision shows the loading to exceed the 2600 kW continuous rating, a Title 10 of the *Code of Federal Regulations* (10 CFR) 50.59 safety evaluation would be performed to assess the impact on the Dresden design and licensing basis. Therefore, because of the licensee adjustments to the EDG loading, the TS SR is now conservative.

Question 2

Does the licensee's test approach of loading the EDG to 1550 to 1600 kVAR for 10 minutes meet the supporting regulatory analysis and intent of the TS requirements?

The pertinent information relating to EDG kVAR rating and the SR is as follows:

DNPS EDG Rating and Loading (kVAR):

	EDG Ratings		EDG Calculated Loads	
	Continuous	10 Percent Overload - 2000 Hr	Short-term (less than 10 minutes)	Long-term (greater than 10 minutes)
kVAR	1950	2145	1155	1557
pf	0.8	0.8	0.88	0.88

The DNPS TS SR 3.8.1.15 requires the licensee to verify each EDG, operating within the power factor limit, operates for > 24 hours:

- a. For ≥ 2 hours loaded ≥ 2730 kW and ≤ 2860 kW; and
- b. For the remaining hours of the test loaded ≥ 2340 kW and ≤ 2600 kW.

Note 2 of the DNPS TS SR 3.8.1.15 states:

If grid conditions do not permit, the power factor limit is not required to be met. Under this condition, the power factor shall be maintained as close to the limit as practicable.

Revision 3 of RG 1.9, Section C.2.2.9 (Endurance and Margin Test) states:

Demonstrate full-load carrying capability at a power factor between 0.8 and 0.9 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.

Note 3 (regarding the load test) of the STS SR 3.8.1.14 states:

If performed with DG synchronized with offsite power, it shall be performed at a power factor \leq [0.9]. However, if grid conditions do not permit, the power factor limit is not required to be met. Under this condition, the power factor shall be maintained as close to the limit as practicable.

Technical Assessment

The DNPS EDG LOOP-LOCA long-term reactive load (>10 minutes) is 1557 kVAR. The licensee's current reactive load test is conducted within a band of 1550 to 1600 kVAR equivalent to 0.83 - 0.86 power factor for a duration of 10 minutes. This test does not demonstrate the capability of the EDG to support the ECCS loading while maintaining the power factor within acceptable limits equivalent to the 24-hour endurance test.

The maximum reactive load (1557 kVAR) is within the test band. This test band is acceptable because it is used to avoid routine overloading of the excitation system. However, testing at the limiting power factor for 10 minutes is unacceptable. As explained above, the lagging power factor increases the load current which increases the demand on the excitation system. It also increases heating of the field windings, armature windings, and stator core. This additional heat load not only affects the winding insulation but also places a greater heat load on the EDG support systems. The licensee's concern that a generator trip during testing would result in accumulated damage to the armature winding due to voltage transients is not warranted. The EDG must be designed to handle a full load rejection without tripping the diesel engine on overspeed or damage to the generator windings. The NRC staff agrees that the greatest challenge to the excitation system is the sequential starting of the large motors during the load sequencing test conducted during refueling outages. However, the duration of this test is very short and for the reasons discussed above, the load sequencing test does not guarantee that the excitation system will function long term nor does this test provide sufficient time to detect incipient failures.

The STS offered some provisions to accommodate cases when the plant conditions cannot allow generation of sufficient kVAR to match design basis kVAR loading. The guidance is to continue to run the test as close as possible to the actual ECCS loading conditions.

Revision 3 of RG 1.9, Section C.2.2.9, "Endurance and Margin Test," states that EDG surveillance testing is expected to demonstrate full-load carrying capability at a power factor between 0.8 and 0.9 for interval of not less than 24 hours. The licensee's testing program is contrary to the NRC staff position conveyed in Revision 3 of RG 1.9, which is to perform the test for 24 hours. The STS requires the reactive load to be at a power factor of \leq 0.9 (plant-specific power factor based on the worst-case design-basis loading) as long as grid conditions permit testing.

The NRC staff finds that the licensee must perform the endurance and margin test for the

24-hour duration of the test at a power factor that envelops the actual ECCS loading of ≤ 0.88 . Hence, the licensee's current method of EDG testing at DNPS is non-conservative in that it does not demonstrate performance of the EDG under worst-case loading and power factor for design-basis conditions for 24 hours. Therefore, the NRC staff finds that the licensee's current method of EDG testing does not meet the intent of the DNPS TS.

3.0 CONCLUSION

The NRR staff finds that the EDG endurance test performed by DNPS, at 2340 to 2600 kW for 22 hours and 2730 to 2860 kW for two hours, was not consistent with the intent of the DNPS TS SR for establishing the operability of the EDG. The TS SR did not envelop the actual power demand requirements for the EDG during design-basis conditions and was, therefore, non-conservative. However, because of the modifications to the EDG loading calculations, as of April 4, 2007, the TS SR is now conservative. If future calculation revisions show the loading to exceed the 2600 kW continuous rating, a 10 CFR 50.59 safety evaluation would be performed to assess the impact on the Dresden design and licensing basis.

The NRR staff further concludes that the licensee's current EDG endurance test procedure, which requires the EDG to run for 10 minutes at the limiting power factor if grid conditions permit, is not consistent with the intent of the DNPS TS SR for establishing operability of the EDG because it does not stress the governor/excitation system, field windings, armature windings, stator core, or the EDG support systems sufficiently long enough to ensure that the EDG will meet the required demand during design-basis conditions. Hence, the NRR staff finds that the licensee's current method of EDG testing at DNPS is non-conservative in that it does not demonstrate performance of the EDG under worst-case loading and power factor for design-basis conditions for 24 hours.

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