

U. S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-255/94017(DRP)

Docket No. 50-255

License No. DPR-20  
EA 94-222

Licensee: Consumers Power Company  
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Jackson, MI 49201

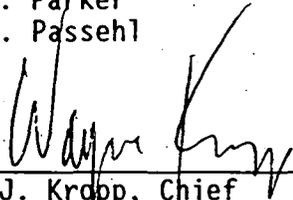
Facility Name: Palisades Nuclear Generating Plant

Inspection At: Palisades Site, Covert, MI

Inspection Conducted: August 30 through October 12, 1994

Inspector: M. E. Parker  
D. G. Passehl

Approved By:

  
W. J. Kropp, Chief  
Reactor Projects Section 2A

Date

10/26/94

Inspection Summary

Inspection from August 30 through October 12, 1994  
(Report No. 50-255/ 94017(DRP))

Areas Inspected: A special unannounced safety inspection by the resident inspectors. The areas inspected were maintenance, surveillance, engineering, and operations; specifically, the ability of the emergency diesel generators (EDGs) to fully supply design basis accident loads.

Results: Three apparent violations were identified involving (1) failure to perform adequate post-maintenance testing; (2) failure to conduct major EDG inspections and overhauls in accordance with vendor recommended practices; and (3) failure to perform an adequate safety evaluation prior to making changes to the EDG load profiles.

## DETAILS

### 1. Management Interview (30703)

The inspector met with licensee representatives denoted in paragraph 7 on October 12, 1994, to discuss the scope and findings of the inspection. In addition, the likely informational content of the inspection report with regard to documents or processes reviewed by the inspector during the inspection was discussed. The licensee did not identify any such documents or processes as proprietary.

### 2. Summary of Events (62703, 61726, 37551, 71707, 93702)

#### a. Emergency Diesel Generator 1-1

Monthly Technical Specification testing of Emergency Diesel Generator (EDG) 1-1 required that the EDG be synchronized and loaded to the range of 2400 kW  $\pm$  100 kW. During monthly testing on July 19, 1994, EDG 1-1 could only achieve 2340 kW when the upper electrical limit of the governor was reached and would not allow the EDG to accept any additional load. Although 2340 kW was within the acceptable range as stated in the Technical Specifications (TS) and the acceptance criteria in the surveillance test procedure, the value was much lower than the 2500 kW that had been observed during past surveillances.

Plant operators contacted system engineering to evaluate acceptance of this test. System engineering personnel reviewed data taken during the test and compared the data to previous tests on the EDG. The licensee identified no significant differences between this and previous tests, other than a slight downward shift in the no-load frequency of the EDG from 63.4 Hz to about 63.2 Hz. The licensee concluded that this slight shift in the no-load frequency may have accounted for the observed decrease in load of the EDG, based upon a corresponding decrease in the speed droop curve of the EDG.

The licensee concluded that the slight downward shift in the speed droop curve would not affect the EDG's ability to carry additional load beyond 2340 kW during plant emergencies involving a Loss Of Offsite Power (LOOP). During a LOOP, the electric governor would be operating in the "unit" (isochronous) mode versus "parallel" (droop) mode of operation.

In the isochronous mode of operation, the generator is the sole source of power to the associated 2400 Vac bus. During a LOOP the 2400 Vac bus frequency is determined by engine speed, and generator load is determined by the load connected to the 2400 Vac bus. In the droop mode of operation, generator output frequency is determined by the frequency of the grid (an "infinite" bus) with the generator output load controlled by the engine governor. The droop mode is used for testing only.

The licensee concluded the EDG was operable after the July 19 test based upon meeting the acceptance criteria of the monthly surveillance test and the fact that the governor would be operating in the isochronous mode during a postulated accident. Another important point was that plant engineers noted that about 3 mm of fuel rack margin was available for additional power out of the EDG at the 2340 kW loading. The licensee initiated a work order to adjust the electrical governor limits to allow recovery of the additional rack margin.

Several days later, on July 29, 1994, the licensee made the adjustment to the electrical governor with telephone assistance from Woodward Governor personnel. At this time the cause for the shift in the no-load frequency was identified. A set screw on a motor-operated potentiometer that sets the speed limits on the EDG was found loose. Electrical personnel tightened the screw and tested the EDG. The power output of the EDG increased somewhat to approximately 2400 kW, but this power level was still below past performance of the diesel generator. The licensee also observed that at 2400 kW, the mechanical governor, the back-up controlling device when the EDG is at rated speed, began to take control away from the electrical governor. The licensee had raised the upper speed limit on the electrical governor to the highest setpoint that was achievable, which corresponded to a no-load frequency of 63.3 Hz. Since the desired setpoint was 64.0 Hz, the licensee assumed that the problem was with the setting of the mechanical governor. A work request was initiated to make adjustments and investigate whether a mechanical governor modification was necessary. The licensee believed that the mechanical governor was now limiting engine output. However, the licensee did not review this against the previous operability determination which was based on a presumed electrical governor problem.

On August 14, 1994, the licensee performed a scheduled monthly surveillance test on the EDG. The peak load recorded was 2370 kW. No maintenance work was performed on the EDG at this time.

On August 30, 1994, the EDG was declared inoperable to work on the mechanical governor. After completing adjustments on the mechanical governor, the licensee tested the EDG and found that the 3 mm of available fuel rack noted on July 19 could not be recovered. The maximum output of the EDG was limited to about 2360 kW (uncorrected), or 2438 kW (corrected). The "as-found" 2438 kW value represented a 372 kW (13.2 percent) decrease in output of the diesel generator as compared to the original manufacturer's peak load test, when 2810 kW was achieved in 1969.

The "corrected" value refers to an instrument calibration that the licensee performed on the control room wattmeter during part of troubleshooting activities. The control room wattmeter was the "official" meter used during the monthly surveillances. This meter was found indicating about 80 kW lower than the true

kilowatt value. The licensee installed a calibrated digital wattmeter for use during subsequent testing to assure that true power readings were obtained.

At this point the licensee then brought in the vendor and commenced extensive troubleshooting that lasted several days. At this time the inspectors questioned the licensee whether the EDG could supply enough power to meet load demands during plant emergencies. The licensee's worst case EDG load profile is based on a Large Break Loss of Coolant Accident (LOCA). Based on this load profile, during a LOCA, EDG 1-1 must be able to supply a peak load of 2688 kW about 30 minutes into the accident.

After further analytical review, the licensee declared the EDG inoperable and provided a 10 CFR 50.72 non-emergency notification to NRC on September 2, 1994, stating that EDG 1-1 may not have been capable of supplying maximum design basis accident loads since the July 19, 1994, surveillance test. A special load test performed on September 3, 1994, confirmed that the EDG 1-1 was unable to supply the 2688 kW. The minimum acceptance criteria for this test was 2705 kW, which took into account the 2688 kW, plus an assumed instrument inaccuracy of 0.5 percent. The EDG only reached a maximum load of 2685 kW, 20 kW short of the acceptance value.

Through troubleshooting, the licensee was able to determine the causes for several of the observed problems. The licensee eventually was able to implement the following corrective actions within the Limiting Condition for Operation (LCO) time frame (7 days), thus preventing a forced shutdown mandated by the Technical Specifications:

- Replaced all 18 fuel injectors and fuel injection pumps.
- Adjusted the governor output linkage.
- Replaced air filters and swapped fuel filters.
- Attempted to inspect the turbocharger which was inconclusive since an adequate inspection required major disassembly.

The special test was subsequently successfully performed following extensive repairs and replacement of the various components. EDG 1-1 was declared operable on September 5, 1994, after achieving a satisfactory loading of 2714 kW.

b. Emergency Diesel Generator 1-2

Although EDG 1-2 had not exhibited similar conditions as that of EDG 1-1, such as the lower power output, for generic reasons the

licensee decided to perform the special peak accident load test on EDG 1-2.

The analyzed peak accident load for EDG 1-2 was 2663 kW, slightly less than that for EDG 1-1. The accident load profile for EDG 1-2 was also similar to EDG 1-1 in that the EDG must be able to supply the peak load about 30 minutes into the accident.

The minimum acceptable load for the special test on EDG 1-2 was 2678 kW, including allowance for instrument uncertainties. The test was performed unsatisfactorily on September 7, 1994, as the EDG achieved 2665 kW, 13 kW short of the acceptance value. The licensee declared the EDG inoperable, entered the appropriate LCO, and made a 10 CFR 50.72 nonemergency report to NRC on September 7, 1994.

The licensee determined the true "as-found" value to be 2651 kW (2665 kW minus the instrument penalty factor), which represented a 176 kW (6.2 percent) decrease in output of the diesel generator from the original manufacturer's peak load test, when 2827 kW was achieved in 1969.

EDG 1-2 required the following relatively minor adjustments to recover 13 kW:

- Adjusted individual fuel rack position to allow further fuel rack travel.
- Adjusted governor throttle linkage and adjusted fuel rack stop.

After the above adjustments, a special load test was performed satisfactorily, with the EDG achieving 2697 kW. On September 8, 1994, EDG 1-2 was declared operable.

### 3. Analysis of Root Cause (62703, 37551)

The inspector and the licensee identified the following root causes for this event.

#### a. Test Control

A review of documentation by the licensee and inspectors identified that, since the early 1980's, there was inadequate control of maintenance activities on the EDG governors and associated linkage.

- On August 30, 1994, the licensee discovered that the EDG was mechanically limited in the isochronous and droop mode to 2438 kW. This was a result of the mechanical governor's output shaft being at full travel due to some prior

misadjustment, thus preventing recovery of the 3 mm of fuel rack the licensee thought was available.

- In 1989, the licensee replaced the electronic governor on EDG 1-1 in 1989 without performing adequate testing. The licensee discovered during their root cause analysis that the governor had been replaced, but has been unable to locate the work order describing this activity.
- On February 4, 1982, the licensee called vendor personnel after observing load instability on EDG 1-1 during testing. According to the vendor's trip report from that time, Woodward Governor Company personnel found the mechanical governor's output linkage incorrectly set which prevented EDG 1-1 from attaining full load.
- On June 2, 1981, (reference licensee corrective action document E-PAL-81-051), the licensee recorded 200 kW load swings on EDG 1-1 during surveillance testing. To solve the problem, the plant technical staff raised the droop setting from 3 percent to 5 percent. Although this solved the load swing problem, plant operators had to raise frequency higher than normal during subsequent tests to achieve proper loading. This higher setting probably caused the interference with the setting of the mechanical governor during the recent event.

The inspectors and the licensee concluded that governor misadjustments during maintenance or modifications performed in the early 1980's were the main cause for the EDGs being unable to attain the power output required by the accident analyses during the recent event. The effect of the misadjustments were insignificant until 1986, when peak accident loads exceeded the Technical Specification required surveillance test of  $2400 \pm 100$  kW. Thus, following the increase in loading above 2500 kW, the licensee was unable to assure that the EDGs would perform satisfactory under design basis accident conditions.

The licensee did not recognize the effect of the misadjustments due to inadequate post-modification or post-maintenance testing, and since the acceptance criteria for the normal monthly surveillance tests continued to be met. More important, however, was that the licensee had never performed a peak accident load test on either EDG over their 25 year service life to ensure that the EDGs could carry loads as described in the plant accident analyses. Had the licensee performed the peak load testing following maintenance and modifications, the effect of the governor misadjustments would have been identified immediately and well before the current problems developed.

The failure to perform peak load testing following governor maintenance to assure the capability of the EDGs to carry maximum design basis accident loads is considered an apparent violation of 10 CFR 50 Appendix B Criterion XI, "Test Control" (50-255/94017-01(DRP)).

b. Maintenance

The licensee failed to perform adequate preventive and corrective maintenance on the EDGs, including vendor-recommended preventive maintenance practices. The following lack of adequate maintenance allowed overall EDG performance to degrade over time:

- 1) The licensee never performed a complete teardown/overhaul on either EDG, in spite of a vendor recommendation to perform such an activity every 12 years or 18,000 hours, whichever came first.
- 2) During the recent event, the licensee procured and installed 18 new fuel injection pumps on EDG 1-1 and noted improved engine performance (about 2500 kW at 30 mm of fuel rack position). The system engineer stated that the fuel pumps on EDG 1-1 had never been overhauled and were the original fuel pumps.

According to the EDG manufacturer's maintenance schedule entitled "ALCO Standby Engine Maintenance Schedule (June 1982)," the licensee was to "remove, recondition, and reapply" several of the major components associated with the diesel engine "every twelve years or 18000 hours, whichever comes first". The 12 year/18000 hour vendor recommended maintenance includes an overhaul of the fuel pumps.

- 3) The lack of effective corrective maintenance on the governor (described in paragraph 2a of this report) and other EDG components contributed to the decrease in peak kilowatt power output from the original manufacturer's testing of 13.2 percent and 6.2 percent for EDGs 1-1 and 1-2, respectively.

One major reason the licensee did not perform the recommended maintenance described in 1) and 2) above was because of the low run times on each EDG. Each EDG had accumulated 3,500 hours over a 25 year period. However, the licensee had not received written vendor or management concurrence in cases where the system engineers believed vendor-recommended maintenance was unnecessary because of the low run times.

Technical Specification 4.7.1.c requires "Each EDG shall be subjected to an inspection, in accordance with procedures prepared in conjunction with the manufacturer's recommendations at least once per refueling cycle during plant shutdown. The licensee

shall utilize his best efforts to conduct additional major diesel generator inspections and overhauls during shutdown periods." The failure to conduct major EDG inspections and overhauls in accordance with vendor recommended practices is considered a violation of Technical Specification 4.7.1.c (50-255/94017-02(DRP)).

c. Safety Evaluations:

The licensee failed to perform an adequate 10 CFR 50.59 safety evaluation when making changes to the EDG load profiles. In 1986 the maximum design basis accident (DBA) loads required to be carried by the EDGs exceeded 2500 kW for the first time. Technical Specification 4.7.1.d, in effect at the time of the 1986 load profile increase, required that EDG electric loads to not be increased beyond the continuous rating of 2500 kW. Had a safety evaluation been performed, the licensee likely would have recognized that an unreviewed safety question existed and would have actively pursued a change to the plant Technical Specifications to allow EDG electric loads to exceed 2500 kW. The inspectors recognized that the licensee submitted a change to Technical Specification 4.7.1.d in 1982 (approved in 1987) to change the 2500 kW limit to 750 amperes at 2400 volts, but this proposed limit was to accommodate the manufacturer's true nameplate rating, and to allow more operational flexibility for operators during monthly surveillance testing. It was not intended to address peak accident loading and the licensee's recognition of DBA electric loads exceeding 2500 kW.

After reviewing past load profile changes the inspector found that the licensee failed to perform a safety evaluation for six of the eight EDG load profile changes beginning in 1986. Load profile changes were made without accompanying safety evaluations on:

- July 14, 1986 (Calc GJB-071486-1)
- April 20, 1987 (Calc DCP-042087-1)
- March 10, 1988 (Calc DRS-031088-1)
- July 9, 1990 (A-PAL-89-117)
- April 29, 1994 (EA-ELEC-LDTAB-005 Rev 1)
- May 9, 1994 (EA-ELEC-LDTAB-005 Rev 3).

The May 9, 1994, load profile change resulted in the maximum DBA loading of 2688 kW (EDG 1-1) and 2663 kW (EDG 1-2).

A safety evaluation was required whenever EDG loads were changed or otherwise affected. EDG load profile changes were controlled

under Administrative Procedure 9.11, "Engineering Analysis (EA)," which was effective October 29, 1993. Step 6.2.1 of this procedure stated that Safety Evaluations were required if the EA being prepared changed the licensing basis for the plant and the EA was not part of another document package which requires a Safety Evaluation. The licensee did not perform a safety evaluation for both the April 29 and May 9, 1994, load profile changes, in part because the new loads were within analyzed limits for the EDG. However, the licensee has subsequently reevaluated this issue and has initiated changes to clarify AP 9.11 requiring a safety evaluation on all EAs.

Adequate safety evaluations prior to changing the EDG load profiles from 1986 to 1994 would have provided the licensee a mechanism to fully evaluate the EDG testing issue, and the licensee would have recognized the need for periodic EDG testing at elevated loading. The licensee should have thoroughly considered in advance of making the load profile changes:

- What parameters of the accident analysis were affected?
- What design basis accidents were impacted?
- What effect would the change have on the margin of safety as defined in the plant Technical Specifications?

The failure to perform safety evaluation when making changes to the EDG load profiles is considered an apparent violation of 10 CFR 50.59 (50-255/94017-03(DRP)).

d. Configuration Control Project Review:

The inspectors reviewed documents that showed the licensee had recognized and evaluated the EDG testing issue, only to conclude that testing at loads above 2500 kW was unjustified.

The licensee had recognized in June 1989 during configuration control project reviews, that the current Technical Specification testing of the Palisades EDGs did not demonstrate maximum load carrying capability. The licensee completed the evaluation of this issue in May 1991.

Regulatory Guide (RG) 1.108, Rev.1, states that EDG testing should be performed at least every 18 months and should demonstrate full load carrying capability for an interval of not less than 24 hours, of which 22 hours should be at the continuous rating (2500 kW for Palisades) and 2 hours at the two hour rating (2750 kW). However, RG 1.108 was not a licensing requirement for plants applying for construction permits before 1977. Since Palisades had a construction permit prior to 1977, RG 1.108 was not applicable.

Some of the reasons stated in the May 1991 configuration control project report for not performing peak load testing were:

- The licensee believed that "routine" overload operation could reduce reliability or even be hazardous to the EDGs. This belief was based in part on that the Palisades' EDGs weren't designed or built to the IEEE 387-1987 definition of the two hour rating. The IEEE definition states that the EDGs should be capable of supplying design loads "...for 2 hours in any 24 hour period." The Palisades' EDGs were designed for 10 percent overload for two hours on "occasional occurrences."
- The licensee believed that the EDGs would perform in an overload condition if needed since this capability was satisfactorily demonstrated during original manufacturer's load tests.
- The licensee believed that overload capability was implicitly demonstrated during routine monthly testing. The licensee correlated satisfactory test results to assurance of optimal reliability.

#### 4. Licensee Actions

The licensee's long term corrective actions include:

- Complete short-duration peak load tests for both EDGs during the October and November 1994 monthly tests.
- Establish appropriate operability criteria in the monthly EDG test procedures to ensure that EDG load carrying capability is verified.
- Establish periodic design basis testing for both EDGs.
- Enhance the preventive maintenance practices on the EDGs.
- Monitor changes to the plant design basis to ensure that potential EDG testing issues are identified and performed.
- Investigate ways to increase the design margin with respect to DBA loads.

#### 5. Safety Significance

This issue was considered significant because the failure of the licensee to perform safety evaluations, adequate maintenance, and adequate post-maintenance testing resulted in the emergency diesel generator system being degraded to the extent that a detailed evaluation was required to determine its operability.

The licensee subsequently completed a preliminary evaluation that found that the EDGs would have been able to satisfy plant design conditions (i.e., peak fuel clad temperature and containment pressure limits).

6. Inspector Conclusions

The inspector concluded that there were the following three apparent violations:

- a. The failure to perform peak load testing to assure the capability of the EDGs to carry maximum design basis accident loads;
- b. The failure to conduct major EDG inspections and overhauls in accordance with vendor recommended practices; and,
- c. The failure to perform an adequate safety evaluation prior to making changes to the EDG load profiles.

7. Persons Contacted

Consumers Power Company

- R. A. Fenech, Vice President, Nuclear Operations
- \*T. J. Palmisano, Plant General Manager
- \*K. P. Powers, Plant Engineering and Modifications Manager
- R. D. Orosz, Director, NOD Services
- R. M. Swanson, Director, NPAD
- \*D. D. Hice, Nuclear Training Manager
- \*D. W. Rogers, Operations Manager
- \*K. M. Haas, Safety & Licensing Director
- \*R. B. Kasper, Maintenance Manager
- \*R. C. Miller, NECO Deputy and Special Projects Manager
- \*C. R. Ritt, Administrative Manager
- \*K. A. Toner, Design Engineering Manager
- \*K. E. Yeager, Electrical Design Engineering Supervisor
- \*P. J. Gire, Licensing Engineer
- \*G. J. Szczypka, Diesel Generator System Engineer
- \*B. A. Low, System Engineering Supervisor
- D. G. Malone, Shift Operations Superintendent
- \*L. D. Seamans, NECO Engineer
- \*D. J. Malone, Radiological Services Manager (acting)
- \*R. A. Vincent, Licensing Administrator
- D. Fadel, NECO Engineering Program Manager
- \*J. Pomaranski, NECO Project Management and Modifications Manager

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- \*M. E. Parker, Senior Resident Inspector
- \*D. G. Passehl, Resident Inspector

\*Denotes those attending the exit interview conducted on October 12, 1994.

The inspectors also had discussions with other licensee employees, including members of the technical and engineering staffs, reactor and auxiliary operators, and shift engineers and electrical, mechanical and instrument maintenance personnel.