June 22, 2001

Mr. J. Sorensen
Site Vice-President
Prairie Island Nuclear Generating Plant
Nuclear Management Company, LLC
1717 Wakonade Drive East
Welch, MN 55089

SUBJECT: PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNIT 2
NRC SPECIAL INSPECTION REPORT 50-306/01-13

Dear Mr. Sorensen:

On May 23, 2001, the NRC completed a Special Inspection at your Prairie Island Nuclear Generating Plant (PINGP). The enclosed report documents the inspection findings which were discussed on May 23 and June 14, 2001, with you and/or other members of your staff.

This inspection examined activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations and with the conditions of your license. The inspectors reviewed selected procedures and records, observed activities, and interviewed personnel.

On April 9, 2001, during a 24-hour surveillance test run of the Unit 2 D6 emergency diesel generator (EDG), members of your staff noticed high crankcase pressure approximately 4 hours into the test. As a result, they shut the EDG down, declared it inoperable, and entered a 7-day Limiting Condition for Operation (LCO). The cause of the high crankcase pressure was later determined to be piston ring blow-by which also resulted in a scuffed cylinder liner. Your staff proceeded with replacing the cylinder liner and piston; however, because they thought the time needed to complete this action might exceed the 7-day LCO, PINGP requested a Notice of Enforcement Discretion (NOED) on April 13, 2001, for an additional 3 days. The 3 days was to allow completion of the EDG repairs without having to shut Unit 2 down. A conference call between Region III, the Office of Nuclear Reactor Regulation, and you and members of your staff was conducted on April 13 to discuss the NOED request. A follow-up conference call was conducted the morning of April 16. During the follow-up conference call, the NOED was granted.

Your staff conducted an evaluation of the scuffed cylinder liner in the D6 EDG and, on May 9, 2001, determined that the root cause of the problem was incompatibility between the fuel oil and lubricating oil. The incompatibility resulted in a buildup of carbon behind the piston rings that then caused the piston rings to protrude sufficiently from the piston that they scuffed the cylinder liner and only effected the Unit 2 EDGs. As a result of you staff coming to this conclusion, your operating crew declared both Unit 2 EDGs inoperable at 3:07 p.m. Central Daylight Time on May 9 and commenced a Unit 2 shutdown. Your staff also indicated that a similar problem had been identified at the Calvert Cliffs Nuclear Plant in 1996 and that the

Institute of Nuclear Power Operations had issued an operating experience report (OE). In addition, the NRC had issued Information Notice (IN) 96-67 in late 1996 on this topic.

Based on risk and deterministic criteria specified in Management Directive 8.3, "NRC Incident Investigation Program," and Inspection Procedure 71153, "Event Followup," a Special Inspection was initiated in accordance with Inspection Procedure 93812, "Special Inspection." The purpose of the special inspection was to evaluate the facts, circumstances, and licensee actions surrounding this event. A charter was developed to focus the inspection effort on the your staff's corrective actions in response to the OE, how they evaluated this issue following the event discussed above on April 9, and corrective actions taken as the result of the May 9th event.

Based on the results of this inspection, the inspectors identified one violation of NRC requirements for which the safety significance was still to be determined. The violation was associated with a failure of your corrective action process to properly identify and resolve previous indications of incompatible diesel fuel and lubricating oils, a condition adverse to quality. This failure resulted in an extended out-of-service time of 206 hours to conduct repairs on the D6 EDG. Both the D5 and D6 EDGs may also have been unavailable for additional time periods before the May 9 shutdown because of the oil incompatibility issue. Both your staff and the NRC were still evaluating the amount of time the EDGs were unavailable at the end of this inspection. The issue will be considered an unresolved item pending completion of those reviews. A preliminary NRC review of the risk significance of the finding determined that it was at least of very low safety significance (Green) based on the known unavailable hours for the D6 EDG.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/NRC/ADAMS/index.html (the Public Electronic Reading Room).

Sincerely,

Original signed by
Geoffrey E. Grant

Geoffrey E. Grant, Director
Division of Reactor Projects

Docket Nos. 50-282; 50-306
License Nos. DPR-42; DPR-60

Enclosure: Inspection Report 50-306/01-13

See Attached Distribution

cc w/encl: Plant Manager, Prairie Island
R. Anderson, Executive Vice President
and Chief Nuclear Officer
Site Licensing Manager
Nuclear Asset Manager
J. Malcolm, Commissioner, Minnesota
Department of Health
State Liaison Officer, State of Wisconsin
Tribal Council, Prairie Island Indian Community
J. Silberg, Esquire
Shawn, Pittman, Potts, and Trowbridge
A. Neblett, Assistant Attorney General
Office of the Attorney General
S. Bloom, Administrator
Goodhue County Courthouse
Commissioner, Minnesota Department
of Commerce

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Sincerely,

/s/Geoffrey E. Grant

Geoffrey E. Grant, Director
Division of Reactor Projects

Docket Nos. 50-282; 50-306
License Nos. DPR-42; DPR-60

Enclosure: Inspection Report 50-306/01-13

See Attached Distribution

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cc w/encl: Plant Manager, Prairie Island
R. Anderson, Executive Vice President
and Chief Nuclear Officer
Site Licensing Manager
Nuclear Asset Manager
J. Malcolm, Commissioner, Minnesota
Department of Health
State Liaison Officer, State of Wisconsin
Tribal Council, Prairie Island Indian Community
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U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket No:	50-306
License No:	DPR-60
Report No:	50-306/01-13
Licensee:	Nuclear Management Company, LLC
Facility:	Prairie Island Nuclear Generating Plant
Location:	1717 Wakonade Drive East Welch, MN 55089
Dates:	May 15 through May 23, 2001
Inspectors:	S. Ray, Prairie Island Senior Resident Inspector S. Burton, Monticello Senior Resident Inspector K. O'Brien, Senior Reactor Inspector, RIII
Approved by:	Roger D. Lanksbury, Chief Branch 5 Division of Reactor Projects

SUMMARY OF FINDINGS

IR 05000306-01-13(DRP), on 05/15-06/14/2001(DRP); Nuclear Management Company, Prairie Island Nuclear Generating Plant, Unit 2. Special Inspection.

This Special Inspection examined the facts and circumstances surrounding the licensee's declaration that both Unit 2 emergency diesel generators (EDGs) were inoperable due to incompatibility between the lubricating oil and fuel oil as well as the actions taken by the licensee to restore diesel operability. This issue only effected the Unit 2 EDGs. The inspection was conducted by the Prairie Island and Monticello Senior Resident Inspectors and a mechanical engineering inspector from Region III. One finding with significance to be determined (TBD) was identified. The finding was preliminarily determined to be of at least very low safety significance (Green). The significance of most findings is indicated by their color (Green, White, Yellow, Red) using IMC 0609, "Significance Determination Process" (SDP). The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described at its Reactor Oversight Process website at http://www.nrc.gov/NRR/OVERSIGHT/index.html. Findings for which the SDP does not apply are indicated by "No Color" or by the severity level of the applicable violation.

A. Inspector Identified Findings

Mitigating Systems

TBD. The inspectors identified a Violation (10 CFR, Part 50, Appendix B, Criterion XVI), in that, the licensee operating experience assessment process failed to critically evaluate or propose appropriate corrective measures for a condition adverse to quality identified in two industry and one NRC generic communications in 1996. As a result, the condition adverse to quality was self-revealed during periodic surveillance testing on April 9, 2001, and resulted in at least 206 hours of D6 Emergency Diesel Generator (EDG) unavailability during Unit 2 operation and possibly additional unavailability for both the D5 and D6 EDGs.

The finding was of at least very low safety significance assuming that the D5 EDG was always available and the D6 EDG was only unavailable during the time period that it was taken out-of-service for repairs. However, both EDGs may have been unavailable for an extended period of time because they were in a degraded condition due to fuel oil and lubricating oil incompatibility. (Sections 4OA3.2 and 4OA3.6)

B. Licensee-Identified Findings

No findings of significance were identified.

Report Details

Summary of Plant Event

On April 9, 2001, during a 24-hour surveillance test run of the Unit 2 D6 emergency diesel generator (EDG), the licensee noticed high crankcase pressure approximately 4 hours into the test. As a result, the licensee shut the EDG down, declared it inoperable, and entered a 7-day Limiting Condition for Operation (LCO). The cause of the high crankcase pressure was later determined to be piston ring blow-by which also resulted in a scuffed cylinder liner. The licensee proceeded with replacing the cylinder liner and piston; however, because the licensee thought the time needed to complete this action might exceed the 7-day LCO, it requested a Notice of Enforcement Discretion (NOED) on April 13, 2001, for an additional 3 days. The 3 days was to allow completion of the EDG repairs without having to shut Unit 2 down. A conference call between Region III, the Office of Nuclear Reactor Regulation, and the licensee was conducted on April 13 to discuss the NOED request. A follow-up conference call was conducted the morning of April 16. During the follow-up conference call, the NOED was granted. Subsequently, the licensee completed the repairs, inspections, and testing of the D6 EDG, declared it operable, and exited the NOED on April 17.

The licensee conducted an evaluation of the scuffed cylinder liner in the D6 EDG and, on May 9, 2001, determined that the root cause of the problem was incompatibility between the fuel oil and lubricating oil. The incompatibility resulted in a buildup of carbon behind the piston rings that then caused the piston rings to protrude sufficiently from the piston that they scuffed the cylinder liner and only effected the Unit 2 EDGs. As a result of coming to this conclusion, the licensee declared both Unit 2 EDGs inoperable at 3:07 p.m. Central Daylight Time on May 9 and commenced a unit shutdown. During the shutdown, the licensee manually tripped the reactor due to a condenser differential pressure problem.

4. OTHER ACTIVITIES [OA]

4OA3 Event Followup (93812)

.1 Sequence of Events

a. Inspection Scope

The inspector reviewed documentation and conducted interviews to determine the chain of events that resulted in the licensee staff declaring the Unit 2 D5 and D6 EDGs inoperable on May 9, 2001.

b. Findings

The inspectors developed the following sequence of events surrounding the event.

Date	Event Description
1996	
01/31	Calvert Cliffs Nuclear Plant experienced EDG problems due to an incompatibility between the EDG low-sulfur fuel oil and the lubricating oil.

05/01 Generic industry communication was issued documenting the Calvert Cliffs EDG problems and root cause (Institute of Nuclear Power Operations (INPO) Operating Experience (OE) 7807).

05/26 The licensee determined that, although the Prairie Island and Calvert Cliffs EDGs were essentially identical, information included in the generic industry communication did not represent an immediate operability concern because the current fuel oil sulfur content was relatively high.

05/30 Updated generic industry communication was issued documenting the Calvert Cliffs' EDG problems and root cause (INPO OE 7869).

07/24 The licensee scheduled a review of the generic industry communications on the Calvert Cliffs' EDG problems to be completed by January 1997.

12/19 The NRC issued Information Notice (IN) 96-67, "Vulnerability of Emergency Diesel Generators to Fuel Oil/Lubricating Oil Incompatibility," with essentially the same information as included in the previous generic industry communications.

1997

01/13 The licensee revised the completion date for reviewing the generic communications to March 1997. As of the end of March 1997 the licensee had taken no additional action.

1998

11/30 The licensee completed a 5-year rebuild of the D6 EDG. No problems were found with the cylinder liners or pistons. The replaced parts were sent to the vendor for refurbishment and later use during the 5-year D5 EDG overhaul.

1999

04/6-9 The licensee performed an inspection of the D6 EDG parts being refurbished by the vendor. All cylinder liners were found acceptable, four pistons were considered unacceptable for reasons unrelated to oil incompatibility.

11/16 The licensee conducted a successful 24-hour surveillance test run of the D6 EDG.

2000

01/03 Licensee revised the due date for completing a review of the generic industry communications regarding the EDGs from November 1998 to November 2000 due to an absence of observed problems, the continued use of higher sulfur content fuel oil, and a perception that the Calvert Cliffs-assumed root cause results may not have been valid.

05/21 The licensee completed a 5-year rebuild of the D5 EDG. The rebuild efforts were completed using the refurbished D6 EDG parts. No significant anomalies were noted with the replaced parts. The D5 EDG replaced parts were scheduled for a future refurbishment by the EDG vendor.

07/31 The licensee staff completed a technical review of the generic industry communications relative to the Calvert Cliffs EDG problems without recommending any changes to the fuel or lubricating oils used for the D5 and D6 EDGs. The review results appeared to rely upon an absence of observed problems with the D5 and D6 EDGs combined with credit taken for the equipment monitoring and preventive maintenance programs.

10/20 The licensee conducted an 18-month preventive maintenance effort of the D6 EDG, including a boroscope inspection of the cylinders. The results of the boroscope exam indicated scratches on one cylinder liner but no other significant problems.

2001

02/12 The licensee staff noted an oil leak during the monthly surveillance test run of the D6 EDG. A work order was written to repair the leak. The licensee staff later concluded that the leak was most likely due to high crankcase pressure and took no action to repair the leak.

03/15 The licensee noted high crankcase pressure during the monthly surveillance test run of the D6 EDG. Corrective measures were planned for the next monthly surveillance test run.

04/09 The licensee attempted to conduct a routine 18-month D6 EDG 24-hour surveillance test run. The EDG loading was decreased 4 hours into the surveillance test run due to high crankcase pressure. Crankcase pressure returned to normal level at the lower loads; however, the surveillance test run was aborted in order to evaluate the situation. The engine vendor was contacted and it recommended a boroscope inspection to determine the cylinder condition.

04/10 Scuffing was discovered on D6 cylinder 2-B1 during the boroscope inspection. The licensee staff, with advice from the vendor, decided to replace the 2-B1 piston and cylinder liner.

04/13 The EDG vendor technical representative arrived onsite and reviewed the condition of the D6 EDG cylinder liners and pistons. The vendor representative noted considerably more carbon buildup on pistons than would be expected for the low number of run hours experienced by the EDG since the last rebuild.

The licensee Operations Committee (OC) discussed a potential need for enforcement discretion from the NRC for the EDG 7-day LCO due to the time necessary to complete the D6 EDG repairs, testing, inspections.

Preliminary discussions were held between the licensee and NRC on the potential need for enforcement discretion.

04/16 Following another OC meeting, the licensee requested and was granted enforcement discretion from the EDG 7-day LCO. The EDG LCO time limit was extended to 10 days.

A 12-hour break-in run and a 24-hour surveillance test run of the D6 EDG were completed and, during a post-run boroscopic inspection, the licensee staff identified unusual indications on the newly installed cylinder liner. As a result, the vendor representative recommended an additional 12-hour run for the D6 EDG.

04/17 The vendor technical representatives communicated to the licensee staff the possibility that the D6 EDG problems may be the result of fuel oil and lubricating oil compatibility problems.

The licensee staff initiated steps to provide the EDG vendor with the latest lubrication and fuel oil samples to determine if a compatibility issue existed with the D5 and D6 EDGs.

The licensee staff completed the additional 12-hour run for the D6 EDG and followup boroscopic inspection. No significant changes were noted from the previously identified indications. The licensee completed a normal fast-start surveillance test run and declared the D6 EDG operable after a total of 206 hours of out-of-service time (8.6 days).

04/18 The licensee received written indications from the EDG vendor that the D6 EDG problems were most likely the result of a fuel and lubricating oil compatibility issue. The EDG vendor requested additional information regarding the fuel and lubricating oils.

04/20 The licensee staff received a copy of the 1996 Calvert Cliffs EDG Root Cause Evaluation Report.

04/27 The licensee requested technical assistance from an independent EDG laboratory to determine the cause for the D6 EDG problems.

04/30 The licensee received a copy of a 1996 independent laboratory technical report on the Calvert Cliffs' EDG fuel and lubricating oil compatibility problems.

05/02 The licensee requested that the independent technical laboratory confirm a fuel oil and lubricating oil incompatibility as the cause for the D6 EDG problems.

The licensee initiated plans to change out the D5 and D6 EDG lubricating oil.

05/08 The licensee's root cause team concluded that the problems with the D6 EDG were caused by the fuel oil and lubricating oil incompatibility issue

and that the lubricating oil in both the D5 and D6 EDGs would have to be changed. The team was unable to determine whether the EDGs could be considered operable in their degraded condition. The general superintendent engineering gave the team 24 hours to make the operability decision.

05/09 The licensee declared both the D5 and D6 EDGs inoperable based on its re-review of 1996 generic industry communications. The licensee conducted a Technical Specification-required shutdown of Unit 2. Instead of a normal shutdown the licensee had to perform a manual trip of the Unit due to unrelated condenser vacuum problems.

05/11 The licensee flushed and replaced the D5 EDG lubricating oil with a lubricating oil designed for use with low-sulfur fuel oil. Subsequently, the licensee conducted a surveillance test run and declared the D5 EDG operable.

Licensee boroscopic inspections of the D6 EDG identified several scuffed cylinders liners and other negative indications which represented a degradation of the conditions observed during the April inspections. Approximately 50 hours of run time had occurred since the April inspections. As a result of the observed conditions licensee management decided to overhaul the D6 EDG.

The NRC concluded that a Special Inspection was warranted to review the various issues surrounding the Unit 2 EDGs.

.2 Corrective Actions to Previous NRC and Industry Information Regarding EDG Problems

a. Inspection Scope

The inspectors reviewed the licensee's actions to evaluate and implement corrective actions in response to previous NRC and industry notices regarding EDG problems.

b. Issues and Findings

The inspectors identified a Non-Cited Violation, in that, the licensee operating experience assessment process failed to critically evaluate or propose appropriate corrective measures in response to two industry and one NRC generic communications which documented EDG fuel and lubricating oil incompatibility problems experienced at the Calvert Cliffs Nuclear Plant in 1996. As a result, similarities between industry conditions and the current or expected EDG fuel and lubricating oil conditions at the Prairie Island Nuclear Plant were not resolved prior to the consequences of the incompatibility being self-revealed during surveillance testing.

In 1996, the licensee received two industry notices, INPO OE Reports 7807 and 7869, and NRC IN 96-67, relative to a potential EDG fuel and lubricating oil incompatibility. The incompatibility involved the use of low sulfur fuel oils with lubricating oils containing additives designed for use with high sulfur fuel oils. Lubricating oils designed for use with high sulfur fuel oil are characterized by a "total base number (TBN)" greater than 10. The industry and NRC communications indicated that the fuel and lubricating oil

incompatibility could result in accelerated deposits on the engine pistons, a buildup of combustion products between the pistons and piston rings, and scuffing of the cylinder liners, resulting in increased piston blow-by of combustion gases. In addition, the licensee staff received other industry communications which described the impacts of operating a diesel engine with incompatible fuel and lubricating oil. The Prairie Island Unit 2 EDGs were built by the same vendor and were essentially identical to the Calvert Cliffs EDGs.

Upon receipt of the industry and NRC notices, the licensee staff performed an initial screening of the notices and determined that no specific immediate action was necessary, in part, due to the then current high diesel fuel oil sulfur content in the storage tanks. At the time of the initial screening, the lowest fuel oil sulfur concentration was approximately 0.18 percent and the lubricating oil TBN was 15. The screening results further documented a need for technical consultations with the EDG engine and oil manufacturers prior to the next scheduled preventive maintenance for the station EDGs. The initial screening was completed in July 1996 and the next EDG preventive maintenance efforts were planned for 1998.

Subsequent to the 1996 initial screening, the licensee continued to purchase low sulfur diesel fuel oil to replenish the EDG fuel oil used as a part of surveillance testing and other operations. As a result, the average EDG fuel oil sulfur concentration in the storage tanks decreased to less than 0.16 percent in 1997, less than 0.14 percent in 1998, and less than 0.10 percent in 1999 due to dilution as low sulfur fuel oil was added. Although the licensee staff expected the diesel fuel oil sulfur concentration to continuously decrease, as evidenced by information included in the initial screening evaluation, the inspectors determined that the screening evaluation did not require periodic monitoring of the fuel oil sulfur concentrations. The screening evaluation also did not require the development of final recommendations prior to the diesel fuel oil sulfur concentration reaching the highest levels referenced in the industry communications, a diesel fuel oil sulfur concentration of approximately 0.12 percent.

The closure file for the OE included two additional entries after the initial screening entry in July 1996. In a January 2000 entry, the licensee approved a change in the assigned completion date for the evaluation from November 1998 to November 2000; acknowledged the continually decreasing diesel fuel oil sulfur concentration; and, noted an apparent disagreement among the industry, EDG vendors, and the Calvert Cliffs staff as to whether a fuel and lubricating oil incompatibility actually caused the Calvert Cliffs EDG problems. The inspectors noted that the entry did not include a basis for extending the evaluation time frame. Further, the assertions included in the entry were not supported by objective evidence.

A final OE entry was added to the closure file in July 2000. The entry writeup indicated: 1) that discussions with oil vendors and other engine manufacturers indicated that current lubricating oils were satisfactory for use in old engines; 2) that the D5 and D6 EDGs could be categorized as “old engines;” and, 3) that the D5 and D6 routine EDG monitoring and inspections had not identified any problems with use of the current lubricating oils. As a result, the OE was closed with a final recommendation of no action except to continue to monitor the EDGs through the routine surveillance testing and preventive maintenance programs.

Based upon a review of other plant records, the inspectors determined that the OE closure was based, in part, on incorrect or unsubstantiated information. For example, the conclusion implied that the EDGs had operated for hundreds of hours prior to the 5-year rebuild of each Unit 2 EDG without any negative performance results due to a fuel and lubricating oil incompatibility. However, the inspectors determined that the fuel oil sulfur concentrations did not decrease to less than 0.12 percent until the approximate time period of the 5-year rebuilds. Further, references to the conclusions of other engine manufacturers were not substantiated as being applicable to the EDGs installed at Prairie Island Unit 2.

In addition, the inspectors identified that the licensee's implementation of the normal surveillance and preventive maintenance program was not adequate to detect degradation of the diesel engines before the problem became self-revealing. Although crankcase pressure was logged during each monthly surveillance test run, the results were not adequately reviewed for trends. During the inspection, the licensee provided the inspectors with plots of D6 EDG crankcase pressure and fuel oil sulfur content which showed a clear correlation over a period of about the last 2 years between gradually decreasing fuel oil sulfur content and gradually increasing engine crankcase pressure. Those trends were not noticed by the licensee until after the April 2001 aborted surveillance test. Indications of D6 EDG crankcase pressure problems during the February and March 2001 monthly surveillance test runs were also not adequately resolved prior t the April 2001 event.

Based upon reviews conducted following the May 9, 2001, inoperability declaration for the D5 and D6 EDGs, the licensee documented in their corrective action program an apparent inadequacy in their evaluation and resolution of the information included in INPO OE 7807 and 7869, and NRC IN 96-67 (Condition Report 20014150).

Criterion XVI, "Corrective Action," of 10 CFR Part 50, Appendix B, requires, in part, that conditions adverse to quality be promptly identified and corrected. Contrary to the above, the failure to identify and correct an incompatibility between the use of low sulfur fuel oil and the lubricating oil installed in the D5 and D6 EDGs between 1996 and 2001 as described in industry and NRC generic communications, a condition adverse to quality, is a violation of Criterion XVI. As discussed in Section 4OA3.6 of this report, the safety significance of this issue had not been determined by the end of the inspection. Therefore, this violation is considered an Unresolved Item pending determination of the safety significance (URI 50-306/01-13-01).

.3 Root Cause for D6 EDG Scuffing Indications

a. Inspection Scope

The inspectors reviewed the as-found condition of components of the D6 EDG removed following the April 2001 surveillance tests and repairs and following the May 2001 inoperability declaration. The inspectors also interviewed individuals involved in these activities and reviewed the licensee's apparent root cause for the observed D6 EDG cylinder 2-B1 liner scuffing.

b. Findings

During and following the April 2001 surveillance testing of the D6 EDG, the licensee took corrective actions to replace a cylinder liner with scuffing indications observed on the D6 2-B1 piston location. However, the licensee did not promptly determine root causes for the finding or determine how the finding could affect the EDG's ability to perform its intended safety function prior to returning the system to service. Subsequently, the licensee identified a potential for the scuffing to be caused by an incompatibility between the EDG use of low sulfur concentration fuel oil and lubricating oil with a high TBN.

Through discussions and interviews with the engineering staff and management, the inspectors determined that the licensee took appropriate actions to shutdown the D6 EDG, during the April 2001 24-hour surveillance test, following indications of high crankcase pressure.

Following identification of the scuff marks on cylinder liner 2-B1, the licensee staff further investigated the status of other cylinders and did not identify any other significant findings. As a result, the licensee initiated a repair effort to remove and replace the 2-B1 piston and cylinder liner. Subsequent satisfactory post-maintenance and surveillance tests of the D6 EDG were conducted and the EDG was returned to service. At the time the EDG was returned to service, the licensee had not determined a root cause for the scuffed cylinder liner or how the finding could affect future EDGs availability or reliability.

From April 16 through May 9, the licensee engineering staff investigated possible causes for the D6 EDG cylinder scuffing. Several potential causes were investigated, including a potential for the scuffing to be caused by an incompatibility between the EDG fuel and lubricating oils. As a result of the initial investigations and information provided by the EDG vendor representative during the initial repair efforts, the licensee staff requested information from the Calvert Cliffs Nuclear Plant and other industry consultants relative to the 1996 Calvert Cliffs EDG problems. Upon review of the information, the licensee staff determined the most likely cause for the scuffing was an incompatibility between the fuel and lubricating oils.

Based upon the apparent findings of incompatible fuel and lubricating oil, the licensee declared both the D5 and D6 EDGs inoperable and shut down Unit 2 on May 9.

Subsequent to the Unit shutdown, the licensee conducted boroscope investigations and a disassembly of the D6 EDG. During these efforts, the licensee identified additional scuffing and other indications. The other indications included excessive carbon deposits on some pistons and the buildup of carbonized deposits between some pistons and piston rings. Samples of these deposits were gathered and analyzed to further confirm the apparent fuel and lubricating oil incompatibility root cause.

Pending final analysis of deposit samples, the licensee staff concluded that the cylinder scuffing which led to the high crankcase pressures was caused by use in the EDGs of low sulfur fuel oil and a lubricating oil with a high TBN.

.4 D5 EDG Operability Status

a. Inspection Scope

The inspectors reviewed the results of past surveillance tests of the D5 EDG, the licensee's corrective actions following the May 2001 inoperability declaration, and the licensee's current operability basis for the D5 EDG.

b. Findings

On May 9, the licensee declared both the D5 and D6 EDGs inoperable based upon indications of a potential fuel and lubricating oil incompatibility. Subsequent to the associated Unit 2 shut down, the licensee performed two 100 percent changes of the D5 EDG lubricating oil with a low TBN oil and appropriate surveillance tests. Following successful completion of the surveillance tests, the licensee declared the D5 EDG operable.

At the time the D5 EDG was first declared inoperable on May 9, the EDG had approximately 40 hours of running time since the last total rebuild and successful testing of the EDG. The fuel oil sulfur concentration was < 0.10 percent during the entire period of time since the rebuild. Therefore, the potential negative effects of the fuel and lubricating oil incompatibility, which affected the D6 EDG, could have been occurring. However, the licensee had not observed any other negative indicators during recent surveillance tests.

Based upon discussions with an independent consultant and the EDG manufacturer, the licensee initially concluded that the D5 EDG remained operable throughout the time period since its last successful surveillance test due to the low number of running hours and the lack of any negative indications during the most recent testing. However, the licensee was still reviewing this determination at the end of the inspection. In addition, the licensee concluded that any negative impacts that may have occurred as a result of operating the EDG with the incompatible fuel and lubricating oils would be halted with the flushing and change out of the lubricating oil to a lubricating oil with a low TBN.

The inspectors reviewed the applicable surveillance tests and lubricating oil vendor information. The licensee's actions to change the EDG lubricating oil to a low TBN oil appeared to be a reasonable and appropriate action to resolve the immediate operability issue. However, the inspectors considered that the amount of past inoperability, if any, before the oil was changed, to be part of the Unresolved Item discussed in Section 4OA3.2 of this report.

.5 Vendor Assessment of As-Found Conditions

a. Inspection Scope

The inspectors interviewed a licensee technical consultant regarding his observations of the condition of the D5 and D6 EDGs and other relevant information on the oil incompatibility issue.

b. Findings

The licensee indicated that the D6 EDG parts removed during the April and May 2001 maintenance efforts exhibited very limited wear. The cylinder liner wear was thought to be most likely caused by piston problems. The problems may have been the result of fuel oil/lubricating oil compatibility problems; however, the licensee did not have sufficient information to make a conclusive assessment. The licensee stated that reviews of the D6 EDG indicated that it was in a condition where it could have run for a significant time before failure. However, the licensee was still evaluating whether it was capable of running long enough to meet its design basis.

During the inspection, the licensee had an industry consultant review the material condition of the D6 EDG 2-B1 pistons and cylinder liners removed in April 2001 and during the forced outage which began on May 9. The consultant also reviewed the status of other components removed from the D6 EDG.

The consultant's reviews identified that the parts showed only very minor wear. The cylinder liners were noted to have greater polishing of the cross-hatching then would be expected for an engine with only about 200 hours of operation since the last major rebuild. However, the consultant also stated the number of engine starts per hour of operation was higher for an EDG in a nuclear plant, adding to the expected wear.

In reviewing the operating and surveillance test data provided by the licensee, the consultant indicated that the high crankcase pressure was usually an indication of piston ring problems. During the May disassembly of the D6 EDG, the licensee identified at least one piston with a ring that was stuck in its groove. Based upon a review of other possible causes and industry experience, the consultant believed that the piston ring and cylinder liner wear indications were most likely the result of fuel and lubricating oil incompatibility.

Finally, the consultant indicated that D6 EDG, at the time of the May shutdown, was likely a long way from failure. The consultant based this opinion on the high load (110 percent of normal load) required to develop the high crankcase pressure, the normal crankcase pressures observed at full load, the maximum load required during an emergency (½ of full load), the very limit amount of observed wear, and industry experience which indicated that wear was proportional to the square of the load. As a result, wear at the emergency load level would be one-fourth that developed during testing.

Some D6 EDG cylinders and pistons were sent to the consultant's lab for further analysis. Those results were not available at the end of the inspection so neither the licensee or inspectors could reach a final conclusion of whether the D6 EDG had been in a condition where it would have been able to meet its design basis.

.6 Operability and Risk Significance of D5 and D6 EDG Status Prior to May 9, 2001

a. Inspection Scope

The inspectors performed a review of the operating status of the D5 and D6 EDGs since 1998 with regard to changing fuel oil sulfur content and performed a preliminary, lower end bound, risk assessment of the issue.

b. Findings

Based upon the information developed, the inspectors could not conclusively determine whether the D5 and D6 EDGs would have been able to perform their intended safety function for the expected mission time as a result of the fuel and lubricating oil incompatibility. However, the inspectors determined that the issue was of at least very low safety significance (Green) based on the known period of unavailability of the D6 EDG, with final significance to be determined (TBD). The inspectors did identify an additional Unresolved Item regarding the completeness of information provided by the licensee prior to, during, and after the NRC granting enforcement discretion in April 2001.

EDG Operability

The licensee completed the 5-year preventive maintenance rebuilds of the D5 and D6 EDGs in May 2000 and November 1998, respectively. During these efforts, the licensee replaced or refurbished many of the EDG components, including the pistons, piston rings, and cylinder liners. Surveillance test data reviewed during the inspection indicated that fuel oil sulfur levels decreased to an average concentration of approximately 0.14 percent in 1998 and to less than 0.10 percent in 1999.

Because the 5-year preventive maintenance effort for the D5 EDG was completed in May 2000, the inspectors determined that all of the EDG's run time, since the rebuild effort occurred, was with low sulfur fuel oil and high TBN lubricating oil conditions. However, licensee data indicated that the overall run time since the rebuild was only about 40 hours. Therefore, degradation of the D5 EDG was expected to be more limited than that observed on the D6 EDG. However, had the D5 EDG been called upon to perform its intended safety function for an extended time between May 2000 and May 2001, the degradation of the components because of oil incompatibility might have caused it to fail. Further information was needed to resolve this question.

Based upon information gathered during the inspection, the inspectors determined that the D6 EDG had been operated since the 1998 rebuild with incompatible fuel and lubricating oils. The D6 EDG overall operating time since the rebuild was approximately 150 hours at the time of the April 2001 problem, and approximately another 50 hours before the oil was replaced in May 2001. In addition, data gathered during the February and March 2001 monthly surveillance test runs of the EDG indicated the beginnings of problems with piston ring deposits and cylinder liner scuffing which culminated with the aborted April 2001 surveillance test run.

The inspectors determined that the D6 EDG was in a more degraded condition than the D5 EDG and had probably been experiencing piston ring blow-by since at least February 2001. However, after observations of the actual parts removed from the D6 engine, review of surveillance test results, and discussions with vendor, consultant, and other technical experts, the inspectors were unable to establish whether the engine could have performed its intended function for its mission time. Further information was needed to resolve this question.

Completeness and Accuracy of Information Provided to the NRC

In an effort to address indications identified during the April 2001 surveillance testing, the licensee initiated corrective maintenance which required the D6 EDG to remain out-of-service in the Technical Specification 7-day LCO. The corrective maintenance efforts included boroscope investigations of the EDG cylinders and the removal and replacement of the 2-B1 piston and cylinder liner. During the middle and later stages of the corrective maintenance activities, the licensee's efforts were observed and guided, in part, by a vendor technical representative.

Approximately 4 days into the 7-day LCO, the licensee determined the corrective maintenance efforts would likely require in excess of the allowed 7-day LCO. In order to allow for continued Unit 2 operations beyond the 7-day LCO period, the licensee requested and received enforcement discretion from the NRC. Concurrent with these discussions, the inspectors determined that some licensee staff were informed by the vendor technical representative that the observed D6 EDG conditions may be the result of fuel and lubricating oil incompatibilities. Interviews with licensee and NRC staff indicated that this information was not included in the licensee's internal discussions or discussions with the NRC as part of the enforcement discretion request.

Subsequent to the NRC's approval of the enforcement discretion, the licensee staff continued the repair efforts and initiated efforts to determine the root causes for the observed cylinder scuffing. Some of these initial efforts to determine the root causes for the cylinder scuffing included obtaining information relative to the Calvert Cliffs 1996 EDG problems. This information appeared to have been requested on the same day as the enforcement discretion was granted and was received 2 days after the repair efforts were completed. Although the licensee staff appeared to have been aware of the potential for the observed D6 EDG cylinder scuffing to be caused by a fuel and lubricating oil incompatibility, a potential common mode failure for the D5 and D6 EDGs, this information was not discussed with the NRC until May 9. The repair efforts were completed on April 18 and the D6 EDG was tested and returned to service.

On May 14, 2001, prior to the start of this NRC Special Inspection, the inspectors requested copies of all relevant licensee documents regarding its analysis and corrective actions for the oil incompatibility issue. On May 15, at the inspection entrance meeting, the inspectors specifically informed the licensee that those documents should include any relevant system engineer notes and e-mails. The inspectors requested that those copies be provided as soon as possible but not later than the afternoon of May 17, 2001. Late on May 17, the inspectors were provided with a copy of industry information on the oil incompatibility issue with handwritten notes by licensee engineers. On May 18, the inspectors were provided with copies of some relevant licensee e-mails. On May 21, the inspectors were provided with copies of a large quantity of relevant licensee e-mails. The inspectors were concerned that the licensee had not provided complete information to the NRC in a timely manner.

The NRC regulations (10 CFR 50.9) require a licensee to provide the NRC with complete and accurate information. Pending a further review of an apparent failure of the licensee to provide complete and accurate information to the NRC, prior to, during, and after their request for enforcement discretion on April 16, and during the NRC Special Inspection, this issue will be tracked as an Unresolved Item (URI 50-306/01-13-02).

Significance Determination Process

On May 9, the licensee concluded that reasonable assurance of operability could not be assured for the D5 and D6 EDGs due to similarities between the Calvert Cliff EDG problems and those observed during the April corrective maintenance activities. As a result, the licensee initiated a shut down of Unit 2. During the shutdown, the licensee experienced condenser vacuum problems prompting the operators to initiate a manual trip of the turbine which resulted in an expected reactor trip. Following the trip, the licensee took the unit to Cold Shutdown and initiated corrective maintenance for both the D5 and D6 EDGs to preclude further degradation of the D5 EDG and to correct observed problems with the D6 EDG due to the fuel and lubricating oil incompatibility. These corrective maintenance efforts continued through the end of the inspection.

The inspectors determined that both the D5 and D6 EDGs could have been degraded and unavailable for some period of time before the problem with high crankcase pressure on D6 became evident in April 2001. In addition, the D6 EDG was definitely unavailable during the time period between April 9 and 18, 2001, when repairs to it were being conducted. In addition, both EDGs could have been unavailable between April and May 9, 2001, after which the oil incompatibility issue was finally identified and resolved.

The inspectors determined that the extended April outage time of the D6 EDG to perform corrective maintenance while Unit 2 operated at full power was the result of a licensee performance issue discussed in Section 4OA3.2 of this report and the finding was a candidate for a preliminary SDP to establish a lower bound for the safety significance of the finding. The inspectors used NRC Inspection Manual Chapter 0609, "Significance Determination Process," Appendix A, dated February 5, 2001, and draft Risk-Informed Inspection Notebook for Prairie Island Nuclear Generating Plant Units 1 and 2, dated October 12, 2000. The finding was more than minor (Group 1 questions) because it had an credible impact on safety by decreasing the availability of one train of emergency power. In addition, if left uncorrected, the issue would have become a more significant safety concern because the condition of the D6 EDG would have continued to degrade. The finding affected the reactor safety cornerstone (Group 2 questions) because it affected the availability of a train of a mitigating system (emergency power). As a result, the inspectors performed a Phase 1 SDP.

Using the SDP Phase 1 Screening Worksheet for the Mitigating Systems Cornerstone, the inspectors concluded that the extended April D6 EDG outage time represented an actual loss of the safety function of a single train of a mitigating system for greater than the Technical Specification allowed outage time, requiring a Phase 2 SDP assessment.

During the Phase 2 SDP assessment, the inspectors concluded that the loss of offsite power (LOOP) scenario, with an initiating frequency of 1 per 10 to 100 years, was the most risk significant for the finding. An exposure time of 3 to 30 days was used because the D6 EDG out-of-service time was at least 206 hours (8.6 days). These combined to make an estimated likelihood rating of "C" in accordance with Table 1 of Manual Chapter 609.

The inspectors further evaluated the most limiting core damage sequence in the LOOP accident sequence tree. The sequence was defined as a LOOP with an initial loss of emergency power and subsequent failure to restore power within five hours. The

evaluation of remaining mitigation capability gave two points credit assuming that the D5 EDG was available, one point credit for operator action to cross-connect Unit 2 to the Unit 1 emergency power supplies, and one point credit for operator action to restore power within five hours. No credit was given for recovery of the failed train because, for most of the out-of-service time, the D6 EDG was not in a condition where it could have been rapidly restored to service. Based upon four points for the remaining mitigation capability rating, the inspectors concluded that the finding was of at least very low safety significance (Green). If it is later determined that the D6 EDG was unavailable for a period of longer than 30 days, or if the D5 EDG is determined to have been unavailable for any length of time during the period that the D6 EDG was unavailable, the significance of the finding, as determined by a revised Phase 2 SDP will increase. Therefore, the safety significance of the finding is TBD and the violation discussed in Section 4OA3.2 of this report is considered an Unresolved Item. The issue is assigned to the Mitigating Systems cornerstone for Unit 2.

4OA6 Meeting(s)

Exit Meeting

The inspectors presented the inspection results to Mr. J. Sorensen and other members of licensee management at the conclusion of the inspection on May 23, 2001. The licensee acknowledged the findings presented. No proprietary information was identified. The inspectors revised the characterization of the inspection results for the finding in the Mitigating Systems cornerstone to an unresolved item during a telephone conversation with Mr. M. Werner on June 14, 2001.

KEY POINTS OF CONTACT

Licensee

T. Allen, General Superintendent Engineering, Nuclear Generation Services
T. Amundson, General Superintendent Engineering
T. Breene, Manager Nuclear Performance Assessment
G. Eckholt, Licensing Manager
L. Gard, General Superintendent Plant Maintenance
J. Kivi, Licensing Engineer
Y. Shen, Probabilistic Risk Assessment Project Manager
T. Silverberg, General Superintendent Plant Operations
J. Sorensen, Site Vice President
M. Werner, Plant Manager

NRC

R. Lanksbury, Chief, Projects Branch 5
S. Burgess, Senior Reactor Analyst

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

50-306/01-13-01	URI	Inadequate Corrective Actions Regarding Fuel Oil and Lubricating Oil Incompatibility for the D5 and D6 EDGs Resulted in an Extended Out-of-Service Time to Repair the D6 EDG
50-306/01-13-02	URI	Potential Failure to Provide Complete and Accurate Information to the NRC

LIST OF ACRONYMS USED

ADAMS	Agencywide Documents Access and Management System
CFR	Code of Federal Regulations
CR	Condition Report
EDG	Emergency Diesel Generator
IN	Information Notice
INPO	Institute of Nuclear Power Operations
IR	Inspection Report
LCO	Limiting Condition for Operation
LOOP	Loss of Onsite Power
NMAC	Nuclear Maintenance Application Center
NOED	Notice of Enforcement Discretion
NRC	Nuclear Regulatory Commission
OA	Other Activities
OC	Operations Committee
OE	Operating Experience
PARS	Publicly Available Records
PM	Preventive Maintenance
SAE	Society of Automotive Engineers
SDP	Significance Determination Process
SP	Surveillance Procedure
TBD	To Be Determined
TBN	Total Base Number
URI	Unresolved Item
WO	Work Order

LIST OF DOCUMENTS REVIEWED

Work Orders (WOs)

WO 0001343	P3001-2-D6 Diesel Generator 18 Month Inspection
WO 0012510	D6 Diesel Generator Slow Start Test
WO 0100917	Leaking Flange/Connection
WO 0104300	High Crankcase Pressure on D6
WO 0104388	Perform D6 Engine Repairs
WO 0104618	Perform Boroscope Inspection on D6
WO 0104718	Repair or Replace Piston Oiler on D6 Engine 2
WO 0104719	SP [Surveillance Procedure] 2335 D6 Diesel Generator 24 Hour Load Test
WO 0104720	SP 2307 D6 Diesel Generator 6-Month Fast Start Test
WO 0104734	SP 2305 D6 Diesel Generator Monthly Slow Start Test
WO 0104735	Perform Boroscope of D6 Following WO 0104734
WO 0107058	Obtain Fuel Oil Samples from D5 and D6
WO 0107060	Change Oil in D6
WO 0107061	Change Oil in D5
WO 0107105	Temporarily Install Crankcase Pressure Monitors
WO 0107151	Isolate and Drain D6 for Liner Replacement
WO 0107153	Replace Defective Components as Necessary

Condition Reports (CRs)

CR 19960719	Issue: 1996027 Action: 1 Fuel Oil Incompatibility in Emergency Diesel Generators
CR 19960761	Issue: 1996070 Action: 1 Lube Oil - Fuel Oil Incompatibility in Emergency Diesel Generator Sets
CR 19960841	Issue: 1996155 Action: 1 Vulnerability of Emergency Diesel Generators to Fuel Oil/Lube Oil Incompatibility

CR 19960895	Issue: 1996070 Action: 1 Develop Recommendations on Future Oils for EDGs
CR 20013265	SP 2118 Not Completed Within 8 Hours, Failed to Meet Technical Specifications Action Statement
CR 20013363	D6 Shutdown After Observing Crankcase Pressure Rise on 24 Hour Run - Boroscope Identified One Cylinder with Minor Blowby
CR 20013473	Not Adhering to the Caution Signs on D5 Room Doors During the D6 NOED
CR 20013490	Failure to Meet Compensatory Measures Requirements of NOED Granted by NRC 04/16/01
CR 20013515	Evaluate Organizational and Process Issues Leading to D6 Repair Time Exceeded the Allowed LCO Out-of-Service Time
CR 20014078	Investigate Piston Ring Failure on D6 with Lab Dimensional and Chemical Analysis to Determine Root Cause
CR 20014150	Issue: 1996070 Action: 1 Lube Oil - Fuel Oil Incompatibility in Emergency Diesel Generator Set (OE7869) - Reassess This External Operations Experience
CR 20014158	During NOED for D6, Caution Sign/No Entry Work in This Area Unless Authorized by Unit 2 Shift Supervisor on Doors - Saw People Enter Without Calling Shift Supervisor
CR 20014237	Reassess Lube Oil - Fuel Oil Compatibility for All Diesels On Site Except D5 and D6 (They are Handled Separately)
CR 20014333	Evaluate 4/16 Request for NOED With Respect to Completeness of Information on Cause of D6 Problems (10 CFR 50.9)
CR 20014346	Perform a Root Cause for the D6 Cylinder Failures
CR 20014467	Assess Weakness in Documentation of Decision Making Raised by NRC Special Inspection of 5/15-5/18/01 and Correct.
CR 20014468	Assess Weakness for Documenting Telecon Conversations Raised by NRC Special Inspection 5/15-5/18/01 and Correct.

Electronic Mail

S. Hiedeman to D. Raebel	D6 Plans	April 16, 2001
P. Hajovy to D. Dugstad and N. Gamble	Results of Latest Lube Oil and Fuel Oil Samples	April 17, 2001
K. Mathieu to D. Carlisle	B1 Cylinder Reassembling - Technical Assistance	April 18, 2001
C. Koehler to S. Hiedeman and others	D5/D6 Fuel Oil Sulfur Content	April 19, 2001
T. Amundson to D. Carlisle	Parts Preparation for Possible Replacement of All 32 D6 Pistons	April 25, 2001
L. Templeton to D. Carlisle and D. Raebel	Wartsila NSD Parts	May 1, 2001
D. Carlisle to J. Vogt	Prairie Island Nuclear Plant Diesel Engine Failure	May 2, 2001
D. Raebel to S. Hiedeman and others	Time Line for Oil Change	May 2, 2001
D. Carlisle to J. Vogt	Prairie Island Nuclear Plant Diesel Engine Failure	May 4, 2001
D. Raebel to L. Templeton	Parts Order Sheet 2001.xls	May 8, 2001
D. Carlisle to J. Kivi	D5/D6 Run Times	May 17, 2001
S. Hiedeman to J. Kivi	Plan on Restoring D6 and Verifying D5	May 17, 2001
C. Wotton to J. Kivi	Some Pictures from Prairie Island of the Pistons	May 17, 2001
J. Vogt to K. O'Brien	Telephone Call Log and Records and Initial E-mail Contacts - Prairie Island	May 18, 2001
C. Wotton to D. Carlisle and T. Allen	Crankcase Pressure Plots	May 20, 2001

Other Documents

Nuclear Management Company Letter to NRC	Request for Notice of Enforcement Discretion Prairie Island Technical Specification 3.7.B	Revision 1, April 16, 2001
NRC Region III Letter to Mr. J. Sorensen	Prairie Island Nuclear Generating Plant - Notice of Enforcement Discretion, NOED No. 01-3-002	April 18, 2001
Nuclear Management Company Letter to NRC	50.9 Report - D6 NOED Compensatory Measures	April 20, 2001
NRC Information Notice 96-67	Vulnerability of Emergency Diesel Generators to Fuel Oil/Lubricating Oil Incompatibility	December 19, 1996
Operating Experience Assessment OE-7807	Lube Oil-Fuel Oil Incompatibility In EDG Set	
Memorandum	From Dirk E. Raebel, to Larry Templeton, “B1 Cylinder Reassembling - Technical Assistance”	April 11, 2001
PINGP [Prairie Island Nuclear Generating Plant] 1324	Event Response Team Checklist - 5/9/01 D5/D6 Inoperable	Revision 0
Southwest Research Institute Letter	From Karen B. Kohl, to Michael Arcaro, Purchase Order # L14656NP Report 1	January 29, 1996
Memorandum MEIU Job# 96-34-15-0023	From Stephanie Coffin, to Jim Adams . . ., Information Regarding Diesel Piston Deposits, Metallurgical Evaluation of Fire and Seal Rings, as Well as Piston Liner Conditions	February 13, 1996
PM [Preventive Maintenance] 3001-2-D6	D6 Diesel Generator 18 Month Inspection - Mechanical (11/7/00	Revision 2
SP 2307	D6 Diesel Generator Slow Start Test	Revision 12
	Electronic Operations Logs - Archived (4/9/01 - 5/17/01)	
	Electronic Limiting Conditions for Operations Log - History (4/9/01 - 5/17/01)	

Memorandum	From Paul Hajovy, to Doug Johnson . . ., Fuel Oil Lube Oil Compatibility	May 14, 2001
Trend Graph	Percent Sulphur Content in Fuel Oil Versus Time (1995 - 2001)	
Trend Graph	D6 Crankcase Pressure Versus Time (1993 - 2001)	
	Operations Committee Meeting Minutes #2641	April 13, 2001
	Operations Committee Meeting Minutes #2642	April 16, 2001
Report by Nuclear Management Company Don Anderson	EDG Design Basis Function Operating Time Requirements	May 17, 2001
SAE [Society of Automotive Engineers] Technical Paper Series 961916	Incompatibility of High Ash Oil for Engines Run on Low Sulfur Diesel Fuel	Copyright 1996 Society of Automotive Engineers
NMAC [Nuclear Maintenance Application Center] Lube Notes, Volume 7, No. 5	Diesel Engine Oils for Engines Burning Low-Sulfur Fuel (with handwritten marginal notes from S. Hiedeman to S. Schaefer)	July 1996
Trip Report from K. Olsen	Inspection of Prairie Island D6 EDG Components at Manufacturer's Facility	April 6-9, 1999