UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
SAM NUNN ATLANTA FEDERAL CENTER
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ATLANTA, GEORGIA 30303-8931

October 11, 2001

EA-01-235

Virginia Electric and Power Company
ATTN: Mr. David A. Christian
Sr. Vice President and
Chief Nuclear Officer
Innsbrook Technical Center - 2SW
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

SUBJECT: SURRY POWER STATION - NRC SPECIAL INSPECTION REPORT NOS. 50-280/01-06 AND 50-281/01-06; PRELIMINARY YELLOW FINDING FOR UNIT 1 AND UNIT 2

Dear Mr. Christian:

On September 26, 2001, the Nuclear Regulatory Commission (NRC) completed an inspection at your Surry Power Station, Units 1 and 2. The enclosed report presents the results of that inspection which was discussed with you and other members of your staff on September 26, 2001. The report includes the preliminary significance determinations relating to failed components in the Number 3 Emergency Diesel Generator (EDG), which is shared by Unit 1 and Unit 2, and to the degraded components in the Number 1 EDG.

The inspection was an examination of 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. Within these areas, the inspection consisted of a selective examination of procedures and representative records, observations of activities, and interviews with personnel.

This report discusses one finding, applicable to both Unit 1 and Unit 2, which appears to have substantial safety significance. For each unit, the failed piston wrist pins and piston carrier bearings in the Number 3 EDG were assessed using the significance determination process (SDP) and the finding was preliminarily determined to be Yellow, i.e., an issue with substantial importance to safety that will result in additional NRC inspection and potentially other NRC action. The finding appears to have substantial safety significance because the failed piston wrist pins and piston carrier bearings would have caused the Number 3 EDG to fail if it had been called upon to operate for a prolonged period to mitigate accident scenarios involving the loss of offsite power. On both units the SDP calculated increase in risk resulted mainly from the time the condition existed on the Number 3 EDG and the "common cause failure to run factor," due to degraded similar components in the Number 1 EDG. In addition, the calculated increase in risk for Unit 2 was greater than Unit 1 because Unit 2 does not have high temperature seals installed on one reactor coolant pump.

Related to this finding are two apparent violations involving: (1) the failure to assure that a condition adverse to quality, involving the failure of equipment, was promptly identified and corrected as required by 10 CFR 50, Appendix B, Criterion XVI and (2) the failure to comply with Technical Specification (TS) 3.16.B.1.a.3 operability requirements for Number 3 EDG. The two apparent violations are being considered for escalated enforcement action in accordance with the "General Statement of Policy and Procedure for NRC Enforcement Actions - May 1, 2000" (Enforcement Policy), NUREG-1600. The current Enforcement Policy is included on the NRC's website at *http://www.nrc.gov/OE*.

Before the NRC makes a final decision on this matter, we are providing you an opportunity to request a Regulatory Conference where you would be able to provide your perspectives on the significance of the findings, the bases for your position, and whether you agree with the apparent violations. If you choose to request a Regulatory Conference, we encourage you to submit your evaluation and any differences with the NRC evaluation at least one week prior to the conference in an effort to make the conference more efficient and effective. If a conference is held, it will be open for public observation. The NRC will also issue a press release to announce the conference.

Please contact Mr. Kerry Landis at (404) 562-4510 within seven days of the date of this letter to notify the NRC of your intentions. If we have not heard from you within 10 days, we will continue with our significance determination and enforcement decision and you will be advised by separate correspondence of the results of our deliberations on this matter.

Since the NRC has not made a final determination in this matter, no Notice of Violation is being issued for the inspection finding at this time. In addition, please be advised that the number and characterization of the apparent violations described in the enclosed inspection report may change as a result of further NRC review.

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,

/RA/

Victor M. McCree, Acting Director
Division of Reactor Projects

Docket Nos.: 50-280, 50-281
License Nos.: DPR-32, DPR-37

Enclosure: Inspection Report Nos. 50-280, 281/01-06

cc w/encl:
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U. S. NUCLEAR REGULATORY COMMISSION

REGION II

Docket Nos.:	50-280, 50-281
License Nos.:	DPR-32, DPR-37
Report Nos.:	50-280, 281/01-06
Licensee:	Virginia Electric and Power Company (VEPCO)
Facility:	Surry Power Station, Units 1 & 2
Location:	5850 Hog Island Road Surry, VA 23883
Dates:	September 5 through September 26, 2001
Inspectors:	R. Musser, Senior Resident Inspector L. Garner, Senior Project Engineer, RII
Approved by:	K. D. Landis, Chief, Reactor Projects Branch 5 Division of Reactor Projects

Attachments:
1. Supplemental Information
2. Silver Content in Lube Oil Samples
3. Phase III Analysis

Enclosure

SUMMARY OF FINDINGS

IR 05000280-01-06, IR 05000281-01-06 on 09/05-09/26/2001, Virginia Electric and Power Co.; Surry Power Station Units 1 & 2. Special Inspection, event follow-up.

This inspection consisted of a review of the inability of the Number 3 Emergency Diesel Generator (EDG) to perform its intended safety function and degraded components on the Number 1 EDG. The review was conducted by the resident inspector and a senior project engineer. This inspection identified a preliminary Yellow finding applicable to Unit 1 and Unit 2 and two apparent violations. The significance of an issue is indicated by it color (green, white, yellow, red) using IMC 0609 "Significance Determination Process" (SDP). Findings for which the SDP does not apply are indicated by "No Color" or by the severity level of the applicable violation. 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*.

A. Inspector Identified Findings

Cornerstone: Mitigating Systems

- To Be Determined. The licensee failed to promptly investigate the cause of an increasing trend in the Number 3 Emergency Diesel Generator (EDG) lubricating oil silver concentration. As a result, the licensee did not promptly identify and correct failed piston wrist pins and piston carrier bearings in Number 3 EDG. Two apparent violations were identified. The first apparent violation involved the failure to assure that a condition adverse to quality, involving the failure of the Number 3 Emergency Diesel Generator, was promptly identified and corrected as required by 10 CFR 50, Appendix B, Criterion XVI. The second apparent violation involved the Number 3 EDG being inoperable for a period of time greater than that which was allowed by Technical Specification 3.16.B.1.a.3.

  The finding appears to have substantial safety significance because the failed piston wrist pins and piston carrier bearings would have caused the Number 3 EDG to fail if it had been called upon to operate for a prolonged period to mitigate accident scenarios involving the loss of offsite power. On both units the SDP calculated increase in risk resulted mainly from the time the condition existed on the Number 3 EDG and the "common cause failure to run factor," due to degraded similar components in the Number 1 EDG. In addition, the calculated increase in risk for Unit 2 was greater than Unit 1 because Unit 2 does not have high temperature seals installed on one reactor coolant pump. (Section 4OA3).

Report Details

4. OTHER ACTIVITIES

4OA3 Event Follow-up

.1 (Closed) LER 50-280, 281/2001-001-00: "Inoperable Emergency Diesel Generator Results in Technical Specification Violation."

a. Inspection Scope

The inspectors reviewed the circumstances surrounding the licensee's discovery of severely degraded piston wrist pins and/or piston carrier bearings associated with seven of the twenty cylinders on No. 3 Emergency Diesel Generator (EDG) (the shared EDG). The degraded components resulted in the No. 3 EDG being unable to perform its intended safety function. In addition, the inspectors reviewed information concerning degradation of these same components on No. 1 EDG. The inspectors reviewed the following documents:

- Licensee Event Report (LER) 50-280, 281/2001-001-00, "Inoperable Emergency Diesel Generator Results in Technical Specification Violation,"
- Plant Issue S-2001-0872, elevated silver levels in No. 3 EDG lube oil,
- Plant Issue S-2001-1168, feel checks reveal that three No. 3 EDG power packs have rough edges on piston wrist pins,
- Category 2 Root Cause Evaluation, "# 3 Emergency Diesel Generator," dated May 23, 2001,
- Engine Manufacturer's (EMD) Maintenance Instruction, MI 1760, "Lubricating Oil for EMD Engines - Marine Power, and Drilling Rig," Revision G,
- Nuclear Engineering Services (NES) Materials Engineering Laboratory Failure Analysis Report NESML-Q-465,
- Engine Systems, Inc. (ESI) Report Number 87360-FA, "Failure Analysis For (1) One Power Assembly, Fork Rod EMD P/N 8470863," Revisions 0 and 1, and
- ESI Report Number 90342-FA, "Failure Analysis For (10) Ten Power Assembly, Fork Rod EMD P/N 8470863 & (10) Ten Power Assembly, Blade Rod EMD P/N 8470864," Revision 0.

The inspectors also reviewed plant operating and maintenance logs and discussed issues and information involving the EDGs with operations, maintenance and engineering personnel. The inspectors evaluated the licensee's compliance with the requirements of 10 CFR 50, Appendix B, Criterion XVI, "Corrective Action," and Technical Specification (TS) 3.16, "Emergency Power System."

b. Findings

The licensee failed to promptly investigate the cause of an increasing trend in the No. 3 Emergency Diesel Generator (EDG) lubricating oil silver concentration. As a result, the licensee did not promptly identify and correct failed piston wrist pins and piston carrier bearings in No. 3 EDG. Two apparent violations were identified. The first apparent violation involved the failure to assure that a condition adverse to quality, involving the failure of the Number 3 Emergency Diesel Generator, was promptly identified and corrected as required by 10 CFR 50, Appendix B, Criterion XVI. The second apparent violation involved the No. 3 EDG being inoperable for a period of time greater than allowed by Technical Specification 3.16.B.1.a.3. Damaged piston wrist pins and piston carrier bearings were also found on the No. 1 EDG. Although the damage in No. 1 EDG was not as extensive as in the No. 3 EDG, the No. 1 EDG was degrading in a manner similar to No. 3 EDG. Consequently, the probability of failure of the No. 1 EDG to successfully perform its intended safety function had also increased.

No. 3 EDG

Plant Issue S-2001-0872 was written on March 22, 2001, concerning the silver content in the No. 3 EDG lube oil being greater than 2.0 ppm in the January 2001 sample. The engine manufacturer's Maintenance Instruction (MI) 1760 details the specifications for lubricating oil and how to interpret the sample analysis. For silver concentrations, MI 1760 specifies the "normal no action required" range as 0 - 1 ppm, the "borderline take extra samples" range as 1 - 2 ppm, and the "high correct condition" range as above 2 ppm. MI 1760 indicates that for silver concentrations in the "high correct condition" range: "Check if oil contains zinc or is corrosive to silver. Check for broken piston cooling tubes, inefficient oil cooler, or improper temperature control. Feel side of piston pins for signs of distress. Measure piston to head clearance with lead readings. Oil draining is not mandatory. Check strainers and bottom of oil pan for debris." These inspections were not completed until the No. 3 EDG was removed from service on April 23, 2001.

The inspectors reviewed the data in Attachment 2 and noted that the licensee had opportunities prior to the issuance of Plant Issue S-2001-0872 to identify the increasing trend in the No. 3 EDG lubricating oil silver concentration. On October 31, 2000, the lube oil silver content in the No. 3 EDG entered the vendor's recommended "high correct condition" range of 2.0 ppm; however, the licensee did not recognize the condition or initiate the actions recommended by the engine manufacturer. The licensee attributed the failure to recognize the "high correct condition" to the computer program that the licensee used to trend the oil sample results and alert personnel to a non-normal value. The computer program had the "high correct condition" range entry value set incorrectly to 10.0 ppm.

Subsequent to the No. 3 EDG being removed from service on April 23, 2001, severe damage was noted on seven of the piston wrist pin and piston carrier bearing surfaces. The damage included displacement of the silver surface on the bearing surfaces such that all or some of the lubricating oil channels were blocked. The fully or partially blocked oil channels would prevent normal oil flow at the bearing/pin interface resulting in increased oil and bearing temperatures and hence additional displacement of silver

material. Thus, damage to the engine occurred not only during engine starts, when full oil pressure is not available, but also during operation. In addition, the number 15 cylinder piston wrist pin and piston carrier bearing had a small contact area between the two parts' base metal. The licensee's NES Materials Engineering Laboratory Failure Analysis Report NESML-Q-465, dated May 7, 2001, states that "In our experience any prolonged operation of the engine with steel on steel contact should have resulted in catastrophic failure of the engine. The fact that such catastrophic failure did not occur suggests that the steel on steel contact noted occurred in the last start or at most the last two or three starts of the engine."

Based upon the as found condition of the No. 3 EDG, the inspectors concluded that the No. 3 EDG was inoperable when it was inspected on April 23, 2001. Thus, the known time the No. 3 EDG was inoperable is the time when it was last operated prior to the April 23 inspection and the date when it was returned to service after replacing all twenty power pack assemblies (cylinder, cylinder head, piston, and rod). This period is from April 15 to April 28, 2001, approximately 13 days, which exceeds the TS 3.16 allowed 7 days an EDG can be inoperable with the reactors at power.

The actual time the No. 3 EDG became unable to operate for a prolonged time to perform its safety function is not known. However, based upon increased silver concentrations in the engine's lube oil samples, the damage to the piston wrist pins and piston carrier bearings began after the No. 3 EDG was returned to service on March 22, 2000 (see attachment 2). Thus, the maximum time period the No. 3 EDG was not able to perform its safety function is from March 22, 2000, to April 28, 2001, a period of 402 days. During this time period, starting and operating the No. 3 EDG resulted in increasing damage and thus reduced assurance that it could continue to operate for a prolonged period after it started. In accordance with standard Probabilistic Risk Assessment (PRA) practices, when the exact time a component is no longer able to perform its safety function is not known, half the interval from when it was last known to be able to perform its safety function (March 22, 2000) to when its ability to perform its safety function was restored (April 28, 2001) is taken as the exposure time in evaluating risk significance. Therefore, the resulting exposure time is 201 days.

To determine if 201 days is reasonable for evaluating the safety significance of the No. 3 EDG damage, two other approaches were considered for determining the exposure time that the No. 3 EDG was not assured to perform its safety functions. The first alternative is based upon the risk models in the Significance Determination Process (SDP) which assumes that the No. 3 EDG needs to run for 24 hours to perform its safety function. From record reviews, the No. 3 EDG ran for a total of approximately 24 hours from October 3, 2000, until it was removed from service for inspection on April 23, 2001. Thus, on and before October 3, 2000, there is reasonable assurance that the No. 3 EDG would have been able to continuously run for 24 hours. However, after October 3, 2000, there was decreasing confidence that the No. 3 EDG could have operated for 24 hours, because the No. 3 EDG had actually run for decreasing time (less than 24 hours) as the date approached April 23, 2001, when the inspection revealed severe damage. Using this date, the No. 3 EDG was no longer assured to be able to perform its safety function for a period of 207 days (October 4, 2000, to April 28, 2001, when the No. 3 EDG was returned to service). The second alternative assumes that exceeding the vendor's action level to "correct condition" at greater than 2.0 ppm silver

corresponds to loss of assurance that an EDG would perform its function. This occurred on October 31, 2000, resulting in an exposure time of 178 days. Thus, the two alternate methods confirm that the mid-point method value of 201 days is reasonable to use in the SDP analysis.

No. 1 EDG

On July 16, 2001, the No. 1 EDG was started for an overspeed trip test but was not loaded and no oil sample was taken. The licensee then removed the No. 1 EDG from service to replace all twenty power pack assemblies. The removed assemblies were sent to the vendor for evaluation. The vendor reported that the number 8 cylinder had a severely damaged piston wrist pin and piston carrier bearing with all the bearing surface oil channels blocked. Seven other cylinders had the beginning of or partial blockage of some of the bearing oil channels. The vendor determined that the severity of the blockage in the No. 3 EDG components was much greater than in the No. 1 EDG.

The licensee considers that the No. 1 EDG was operable, i.e., capable of performing its intended safety functions, prior to the maintenance. The inspectors considered the licensee's conclusion as credible because the silver concentration in the No. 1 EDG lube oil (see attachment 2) had no discernable trend between January 2000 and July 1, 2001, the date of the last surveillance test prior to the maintenance. Furthermore, the damage to the number 8 cylinder components could have occurred during the last two engine starts and runs. This is unlike the No. 3 EDG for which it is improbable that the severity of damage to seven cylinder piston wrist pins and piston carrier bearings could have occurred in the last few starts and operations of the engine. The degraded No. 1 EDG was considered when assessing the risk significance of the No. 3 EDG failure by adjusting the "common cause failure to run factor."

Root Cause Evaluations (RCEs)

The licensee has completed their RCE for the No. 3 EDG. In the RCE, the licensee concluded that the degradation and failure of the piston wrist pins and piston carrier bearings resulted "from a temporary loss (or delay in lubrication) over a period of time." After considering various causes, the licensee was unable to determine the root cause of this lubrication loss. Although the lube oil silver content for the No. 1 and 3 EDGs increased from historic values (see attachment 2) after a change of lube oil vendors, no similar change was observed for the No. 2 EDG after the lube oil vendor change. The RCE for the No. 1 EDG is in progress. Based upon the damage in the No. 1 and 3 EDGs, the licensee is reviewing the adequacy of the vendor's recommended value of 2.00 ppm silver content to detect an impending failure of these components.

Safety Significance

The intended safety function of the emergency diesel generators is to mitigate accidents involving the loss of offsite power. For loss of all alternating current (AC) power, the licensee has installed a non-safety related alternate AC (AAC) diesel generator. A significance determination process (SDP) analysis was performed to determine the risk significance of the finding, i.e., having a reduced assurance that the No. 3 EDG could operate for a prolonged period after it started. The analysis characterized the finding as

Yellow for Unit 1 and Yellow for Unit 2 (see attachment 3). A Yellow finding is an issue with substantial importance to safety. On Unit 1 and 2, the calculated increase in risk resulted mainly from the time the condition existed on the No. 3 EDG and the "common cause failure to run factor" due to similarly degraded components in the No. 1 EDG. In addition, the calculated increase in risk for Unit 2 was greater than Unit 1 since Unit 2 does not have high temperature seals installed on one reactor coolant pump.

Apparent Violations (AVs)

Two AVs were associated with the finding. 10 CFR 50, Appendix B, Criterion XVI, states, in part, that measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and non-conformances are promptly identified and corrected. The licensee failed to investigate, until April 23, 2001, the cause of the increasing silver concentrations in the No. 3 EDG lube oil which began in March 2000. The licensee also had an opportunity to identify the adverse condition on October 31, 2000, when the lube oil silver concentration in the No. 3 EDG entered the vendor's recommended "high correct condition" range of 2.0 ppm. As a result, the licensee failed to promptly identify and correct a condition adverse to quality, i.e., the damaged piston wrist pins and piston carrier bearings in the No. 3 EDG, as required by 10 CFR 50, Appendix B, Criterion XVI. This failure to comply with Criterion XVI requirements is identified as AV 50-280, 281/01006-01.

TS 3.16.A.1 requires, in part, that a reactor shall not be operated such that the reactor coolant system pressure and temperature exceed 450 psig and 350 degrees Fahrenheit, respectively, without two diesel generators (the unit diesel generator and the shared backup diesel generator) OPERABLE. TS 3.16.B modifies the requirements of TS 3.16.A. TS 3.16.B.1.a.3 requires, in part, that during power operation, if either unit's dedicated diesel generator or shared backup diesel generator is not returned to an OPERABLE status within 7 days, the reactor shall be brought to HOT SHUTDOWN within the next 6 hours and COLD SHUTDOWN within the following 30 hours. As discussed above, the No. 3 EDG, the shared backup diesel generator, was not operable from April 15 to April 28, 2001. During this 13 day time period both Unit 1 and 2 operated at or near full power, i.e., pressure and temperature exceeded 450 psig and 350 degrees Fahrenheit, respectively. Operating Unit 1 and 2 at or near full power with the No. 3 EDG being inoperable for greater than 7 days is a failure to comply with the requirements of TS 3.16.B.1.a.3. This failure to comply with the TS is identified as AV 50-280, 281/01006-02.

4OA6 Management Meetings

Exit Meeting Summary

Mr. K. Landis, Chief, Reactor Projects Branch 5, Region II, and the inspectors presented the inspection results to Mr. D. Christian, Sr. Vice President and Chief Nuclear Officer, and other members of the licensee's staff on September 26, 2001.

The inspectors asked the licensee whether any of the material examined during the inspection should be considered proprietary. No proprietary information was identified.

Attachment 1

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee
M. Adams, Manager, Engineering
R. Allen, Manager, Maintenance
R. Blount, II, Site Vice President
M. Crist, Manager, Nuclear Oversight
B. Foster, Director, Nuclear Station Safety and Licensing
M. Small, Supervisor, Licensing
T. Sowers, Director, Nuclear Station Operations and Maintenance
J. Swientoniewski, Manager, Operations

NRC
W. Rogers, Senior Reactor Analyst, RII

ITEMS OPENED AND CLOSED

Opened

50-280, 281/01006-01	AV	Failure to promptly identify and correct a condition adverse to quality, the failed piston wrist pins and piston carrier bearings in the number 3 emergency diesel generator, as required by Criterion XVI of 10 CFR 50 Appendix B (Section 4OA3).
50-280, 281/01006-02	AV	Number 3 emergency diesel generator inoperable for 6 days longer than the 7 days allowed by Technical Specification 3.16.B.1.a.3 (Section 4OA3).

Closed

50-280, 281/2001-001-00	LER	Inoperable Emergency Diesel Generator Results in Technical Specification Violation (Section 4OA3).

Attachment 2

SILVER CONTENT IN LUBE OIL SAMPLES

NUMBER 1 EDG[1]	
DATE	PPM[3]
3/99	<0.1
4/99	0.19
7/99	0.38
8/99	0.53
8/99	0.44
10/99	0.89
11/99	0.32
1/00	1.00
3/00	1.02
6/00	0.81
7/00	0.96
8/00	0.84
9/00	0.91
10/00	0.96
11/00	0.88
12/00	0.85
1/01	0.86
2/01	0.97
4/01	1.15
5/01	1.06
6/01	1.19
7/01	1.15

NUMBER 3 EDG[2]	
DATE	PPM[3]
4/00	0.63
5/00	0.77
6/00	1.11
7/00	1.69
8/00	1.86
9/00	1.83
10/00	2.01
11/00	1.95
12/00	2.03
1/01	2.55
2/01	No Data
3/01	2.60
4/01	1.90

Notes: 1. Lube oil changed in 2/99.
2. Lube oil changed in 3/00. Between 7/96 - 3/00 silver content was in the normal range (0.10 - 0.17 ppm).
3. Data accurate to +/- 0.1 parts per million (ppm). Greater than 2.00 ppm is in “high correct condition” range.

Additional Note: Number 2 EDG lube oil was changed in 10/99. Silver content remained at approximately 0.2 ppm after the oil change.

Attachment 3

PHASE III ANALYSIS

SRA Analysis Number: SUR 0102
Analysis Type:SDP Phase III
Inspection Report Nos.: 50-280, 281/01-006
Plant Name: Surry (3 loop Westinghouse with a sub-atmospheric containment)
Unit Number:1 & 2
Enforcement Action No.: EA-01-235

I. Background:

In March 2000, No. 3 EDG's engine oil was changed from an Amoco Oil product to a Chevron Oil product. On 3/22/2000 the EDG was returned to service. Prior to this oil change, silver content within the lube oil remained at less than .17 ppm. Over the next few months the silver content in the oil increased:

04/00 Ag .63 ppm.
05/00 Ag .77 ppm
06/00 Ag 1.11 ppm
07/00 Ag 1.69 ppm
08/00 Ag 1.86 ppm
09/00 Ag 1.83 ppm
10/00 Ag 2.01ppm
11/00 Ag 1.95 ppm
12/00 Ag 2.03 ppm
01/01 Ag 2.55 ppm
02/01 Ag Data Missing
03/01 Ag 2.60 ppm
04/01 Ag 1.90 ppm (actually 4/15/01)

At > 2.0 ppm[10/00] the oil's Ag content exceeded EMD's (manufacturer's value) high limit. EMD's published recommended actions were to:

① Check if oil contains zinc or is corrosive to silver.
② Check for broken piston cooling tubes, inefficient oil cooler, or improper temperature control.
③ Feel side of piston pins for signs of distress.
④ Measure piston to head clearance with lead readings.
⑤ Check strainers and bottom of oil pan for debris.

However, it was not until 3/22/01 that a problem report, PI S-2001-0872, was written indicating the Ag content exceeded the 2.0 ppm limit. The vendor recommendations for high Ag content were acted upon on 4/23/01. On 4/23/01, No. 3 EDG was discovered to be severely degraded in that 7 of 20 piston pin bearings exhibited significant damage such that the engine would not have been capable of performing its intended function if called upon. Feeling the side of the piston pins for signs of distress revealed the damage. Also, there was heavy debris observed when checking the strainers and the bottom of the oil pan. Following repairs the EDG was returned to service on 4/28/01.

Performance Deficiency - The licensee failed to establish measures to assure that a condition adverse to quality, involving the failure of equipment, was promptly identified and corrected. Specifically, the licensee did not promptly identify and correct a degradation of the No. 3 EDG piston pin bearing surfaces as indicated by an increasing trend in the No. 3 EDG lubricating oil silver content.

Exposure Time - 201 days - In retrospect, full confidence that the EDG could perform its complete mission time was lost when the EDG was returned to service after changing the type of lubricating oil. That was 3/22/00. Full confidence that the EDG could perform its complete mission time was restored upon return to service after the power pack repairs. That was 4/28/01. Since an extact time can not be established at which the EDG would not fullfil its mission time, one half of this time duration has been selected as the exposure time.

Date of Occurrence - Between 3/22/00 and 4/28/01

II. Safety Impact: U1 = Yellow
U2 = Yellow

III. Risk Analysis/Considerations

Assumptions:

1. Due to the extent of the damage observed in April, it is not reasonable to assume that the EDG could have fulfilled its 24 hour mission time. Also, continued operation of the EDG would result in an imminent failure of the EDG. The most reasonable PRA basic event for modeling the performance deficiency for the exposure period is “Failure to Run.”

2. Recovery of the swing (No. 3) EDG is not credible.

3. Unit 1's RCP seals are high temperature. One of Unit 2 RCPs has the old style Westinghouse seal. RCP Seal LOCA probabilities used will be consistent with the Rhodes model.

4. The performance deficiency of not acting on an increasing trend or out of specification oil analysis is a credible common cause failure modifier. The same acceptance criteria of 10 ppm was applicable to the three EDGs. Therefore, the same factor would be applicable, if another EDG had gone out of specification high. Also, one of the other EDGs had increasing Ag content which had not exceeded the vendor specification, however, damage was detected. The extent of the damage was not comparable to that observed in the swing EDG.

PRA Model used for basis of the risk analysis: Licensee's full scope model

Significant Influence Factor(s) [if any]: Exposure Time. Initial discussions between resident inspectors and licensee indicate a disagreement on exposure time. The licensee considered the fault exposure time from the last successful EDG surveillance

(approximately 8 days). Different types of RCP seals are installed between the two units which significantly changes the probability of a seal LOCA.

IV. Calculations

a. Unit 2

1. Scoping Calculation for Unit 2 using Licensee Full Scope Model information [the model is for Unit 2 with the old style Westinghouse seals]

4.35 = RAW for No. 3 EDG FTR

4.35 * 8.4E-6 [baseline CDF] = 3.7E-5

Delta CDF for one year would be: 3.7E-5 - 8.4E-6 = 2.8E-5

Exposure Time = 201 days

Therefore, the Total Delta CDF is:

2.8E-5 * (201 / 365) = 1.5E-5

or 7.5E-8/day

2. Actual Computer Run

The basic event for No. 3 EDG fail to run, 3EEEDG-FR-3EEEG1, was set to True and the common cause basic event, 1EEEDG-2R-12 was set to .03. The .03 was derived from NUREG/CR-5497, “Common-Cause Failure Parameter Estimations.” The model was then re-quantified. The dominant cutsets from the licensee's full scope model are provided in reference #1 [surry edg3 ftr old seals]. These accident sequences generally involve independent failure of No. 1 EDG, the SBO DG & failure to recover offsite power before the onset of core damage. There are multiple failure modes for the diesel generators involving failure to start, failure to run or unavailable for maintenance. The different combinations of failures leading to an SBO make up the dominant cutsets. The delta CDF was comparable to the scoping calculation, considering that the scoping calculation did not include a modification to common cause. The CDF increase was 5.7E-5. The delta CDF was:

5.7E-5 - 8.4E-6 = 4.86E-5 * [201 / 365] = 2.7E-5

3. External Events Consideration

Only the external events that cause a LOSP will be considered.

Seismic - Based upon IPEEE page 3-35 a .3g ground acceleration frequency will be the initiating event frequency for an earthquake causing a LOSP without offsite power recovery for 24 hours. From page 2-2 the annual frequency of exceeding .3g ground acceleration is 1.5E-5. The two basic events in the full scope model of T1 & PROB-CU-2 give a product of 7.68E-2 * 1.34E-1 = 1E-2. These two basic events encompass a LOSP and the combined seal LOCA/non-recovery probability. Therefore, to understand the potential risk increase from the performance deficiency you can compare this 1E-2 to the earthquake induced LOSPs without offsite power recovery of 1.5E-5. The rest of the accident sequence basic events should not change. Therefore, the risk contribution would be magnitudes less than from the internal events contribution and will not be further considered.

Fire - Assuming a fire that induces a LOSP without offsite power recovery, No. 1 EDG or the SBO DG would have to be impaired by the fire to be of any serious consideration. The surrogate for this external event will be the electrical switchgear room. The licensee's IPEEE submittal was reviewed. The affected accident sequences were derived from the event trees (Appendix A5) that included EDG operation. From the tables (Chapter 4) for those event trees, the cutsets that included the No. 3 EDG Fail to Run basic event or the common cause basic event were determined. The cutsets were modified by dividing the base No. 3 EDG fail to run term of 5E-2 by the cutset's CDF. This would give the risk increase for one year due to No. 3 EDG always failing in the run condition. The results were:

Event Tree	original CDF	new CDF
F111/S05	9.5E-9	1.9E-7
F302/S10	8E-10	1.6E-8
F302/S18	2.9E-8	5.8E-7
F302/S37	5.7E-9	1.1E-7
F302/S37 CCF contribution	7.5E-10	1.9E-7
F302/S44	1.1E-8	2.2E-7
F313/S18	3.87E-9	7.7E-8
F313/S37	2.7E-8	5.4E-7
F313/S37 CCF contribution	8E-10	2.1E-7
F313/S44	2.5E-8	5E-7
F314/S21	1.3E-9	2.6E-8
F314/S40	1.36E-8	2.7E-7
F314/S40 CCF contribution	4E-10	1.1E-7
F314/S47	1.3E-8	2.6E-7

F131/S18	7E-8	1.4E-6
F131/S30	5.2E-10	1E-8
F131/S37	3.4E-8	6.8E-7
F131/S37	1.3E-9	3.4E-7
F131/S44	3E-8	6E-7
F132/S13	1E-9	2E-8
F133/S13	3.5E-9	7E-8
F133/S18	7.1E-9	1.4E-7
F134/S13	1E-10	2E-9
F134/S18	6.7E-9	1.3E-7
TOTALS	2.96E-7	6.69E-6

This indicates a [6.69E-6 - 2.96E-7] * 201 / 365 = 3.5E-6 CDF contribution from fire.

Other - The IPEEE screened out any other possible contributors.

4. Total delta CDF

2.7E-5 {Internal Events} + 3.5E-6 {External Events} = 3.05E-5

b. Unit 1

1. The conforming condition - To take into consideration the improved RCP seal design, applicable basic events were modified in the full scope model. These changes involve reducing the seal LOCA probability and changing offsite power non-recovery probabilities allowing more time for power restoration. The baseline CDF for new style Westinghouse seals is 4.78E-6.

2. The non-conforming condition - The basic event for No. 3 EDG FAIL TO RUN was set to TRUE and the common cause EDG term was set to .03. Also, the RCP seal LOCA probability was modified to .2 and the offsite power non-recovery term was appropriately modified. The re-quantified model indicated a 2.5E-5 CDF.

3. Internal Events Delta CDF for the exposure time - The delta CDF is:

2.5E-5 - 4.78E-6 = 2E-5 * [201 / 365] = 1E-5

4. External Events Contribution Consideration - Consistent with the Unit 2 analysis, only the fire risk contribution will be quantified. LOSPs due to earthquake, high winds or external flood would increase the risk. However, the initiating event

frequency would be magnitudes less than what is used for internal events. The accident sequences from the fire IPEEE involving the No. 3 EDG fail to run or common cause failure basic event were evaluated by assuming all cutsets involving the offsite power non-recovery term would not lead to core damage. It is assumed that all sequences involving the non-recovery term were seal LOCA sequences. Therefore, the lower probability of seal LOCA for this unit has been considered. This affects the sequences from event trees F302S10, F302S37, F313S37, F314S40, F131S37. The resulting delta CDF = [4.2E-6 - 2.1E-7] * [201 / 365] = 2.2E-6

5. Total delta CDF

   1.1E-5 {Internal Events} + 2.2E-6 {External Events} = 1.3E-5

V. Conclusions/Recommendations - Yellow for Unit 2 and Yellow for Unit 1.

VI. References
   1. Dominant Cutsets (Unit 2)

Analyst: W. Rogers Date: 8/20/01

Reference #1

Dominant Cutsets for Old Style Westinghouse Seals

Top event unavailability (rare event) = 5.707E-005

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1 2.95E-006 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-TM-1EEEG1
AACEDG-TM-DG0M DUMY-1H-FAILURE DUMY-1J-FAILURE
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR

2 2.87E-006 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-2R-12
AACEDG-TM-DG0M DUMY-1H-FAILURE DUMY-1J-FAILURE
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR

3 2.75E-006 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-TM-1EEEG1
AACEDG-FS-DG0M DUMY-1H-FAILURE DUMY-1J-FAILURE
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR

4 2.67E-006 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-2R-12
AACEDG-FS-DG0M DUMY-1H-FAILURE DUMY-1J-FAILURE
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR

5 2.30E-006 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-TM-1EEEG1
DUMY-1H-FAILURE DUMY-1J-FAILURE HEP-AP17:06
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR

6 2.23E-006 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-2R-12
DUMY-1H-FAILURE DUMY-1J-FAILURE HEP-AP17:06
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR

7 1.81E-006 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-FS-1EEEG1
AACEDG-TM-DG0M DUMY-1H-FAILURE DUMY-1J-FAILURE
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR

8 1.68E-006 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-FS-1EEEG1
AACEDG-FS-DG0M DUMY-1H-FAILURE DUMY-1J-FAILURE
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR

9 1.60E-006 LERF-44 IE-VX

10 1.52E-006 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO

PROB-SL01 IE-T1 1EEEDG-TM-1EEEG1
AACEDG-FR-DG0M DUMY-1H-FAILURE DUMY-1J-FAILURE
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR
11 1.48E-006 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-2R-12
AACEDG-FR-DG0M DUMY-1H-FAILURE DUMY-1J-FAILURE
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR
12 1.41E-006 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-FS-1EEEG1
DUMY-1H-FAILURE DUMY-1J-FAILURE HEP-AP17:06
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR
13 1.04E-006 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-FR-1EEEG1
AACEDG-TM-DG0M DUMY-1H-FAILURE DUMY-1J-FAILURE
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR
14 9.75E-007 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-FR-1EEEG1
AACEDG-FS-DG0M DUMY-1H-FAILURE DUMY-1J-FAILURE
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR
15 9.30E-007 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-FS-1EEEG1
AACEDG-FR-DG0M DUMY-1H-FAILURE DUMY-1J-FAILURE
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR
16 8.14E-007 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-FR-1EEEG1
DUMY-1H-FAILURE DUMY-1J-FAILURE HEP-AP17:06
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR
17 5.38E-007 XCOM-Q-ASL PROB-CU-2 LERF-05
XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-FR-1EEEG1
AACEDG-FR-DG0M DUMY-1H-FAILURE DUMY-1J-FAILURE
1EE-BAT-1A-4HOUR 1EE-BAT-1B-4HOUR
18 3.04E-007 XCOM-RCLL201 LERF-20 1EEEDG-TM-1EEEG1
MULT-SWYD-6-T9 IE-T9A-SM 0EPBUS-LU-BUS6
1VSSV--SO-RV313 DUMY-1H-FAILURE DUMY-2J-FAILURE
MULT-DG-24HR-T9 1EE-BAT-1A-4HOUR HEP-1E0-12-NOCLS
HEP-1E0-12C
19 2.95E-007 XCOM-RCLL201 LERF-20 IE-T9A-SM
MULT-SWYD-6-T9 1EEEDG-2R-12 0EPBUS-LU-BUS6
MULT-DG-24HR-T9 1VSSV--SO-RV313 DUMY-1H-FAILURE
DUMY-2J-FAILURE 1EE-BAT-1A-4HOUR HEP-1E0-12-NOCLS
HEP-1E0-12C
20 2.95E-007 XCOM-Q-ASL PROB-CU-2 LERF-05

XCOM-LT01 XCOM-Q02 HEP-CROSSTIE-SBO
PROB-SL01 IE-T1 1EEEDG-TM-1EEEG1
AACEDG-TM-DG0M DUMY-1H-FAILURE DUMY-1J-FAILURE
1EE-BAT-1B-4HOUR REC-INAIR-LOCAL