UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
SAM NUNN ATLANTA FEDERAL CENTER
61 FORSYTH STREET, SW, SUITE 23T85
ATLANTA, GEORGIA 30303-8931

February 28, 2007

EA-07-024

Carolina Power and Light Company
ATTN: Mr. James Scarola
Vice President
Brunswick Steam Electric Plant
P. O. Box 10429
Southport, NC 28461

SUBJECT: BRUNSWICK STEAM ELECTRIC PLANT - NRC INSPECTION REPORT NOS. 05000324/2007008 AND 05000325/2007008; PRELIMINARY WHITE FINDING

Dear Mr. Scarola:

On February 28, 2007, the Nuclear Regulatory Commission (NRC) completed an in-office open item review for your Brunswick facility. The enclosed inspection report documents the inspection results, which were discussed on February 28, 2007, with you and other members of your staff.

The 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 review was an in-office examination of unresolved item (URI) 05000325,324/2006005-01, Trip of Emergency Diesel Generator (EDG) #1 and Failure of Engine Crankshaft Bearing, which was identified in NRC Inspection Report No. 05000325,324/2006005 and forwarded to Progress Energy-Carolina Power and Light Company (CPL) on January 30, 2007. This issue was unresolved pending further NRC review.

Based on the results of this review, the inspectors identified a finding involving inadequate corrective actions to prevent a repeat failure of the #9 main crankshaft bearing on EDG #1, the failure to follow the foreign material exclusion procedure during maintenance performed on EDG #1, and the failure to promptly identify and implement adequate actions to prevent EDG #1 from tripping on low lubricating oil pressure. This resulted in Unit 1 failing to satisfy Technical Specification 3.8.1, AC Sources-Operating, from October 30, 2006, until the condition was corrected on November 7, 2006.

The finding was assessed based on the best available information, including influential assumptions, using the applicable significance determination process (SDP) and was preliminarily determined to be a White finding for Unit 1 (i.e., a finding with some increased importance to safety, which may require additional NRC inspection) and a finding of very low safety significance (Green) for Unit 2. The safety significance of the finding was determined based on assuming a loss of offsite power initiating event and EDG #1 being in a degraded condition for approximately 3 days and in a nonfunctional condition for approximately 5 days. The difference in risk significance between the units is due to differences in electric bus loads.

A detailed description of the preliminary risk assessment is contained in Enclosures 1 and 2. For Unit 1, the finding was also characterized as an Apparent Violation (AV) of Technical Specification 3.8.1 and is being considered for escalated enforcement action in accordance with the NRC Enforcement Policy. The finding initially presented an immediate safety concern. However, your staff took prompt actions to investigate and repair the problem. Further, EDG #1 was subsequently tested successfully. In addition, this matter was entered into your corrective action program to address long-term corrective actions. In accordance with Inspection Manual Chapter (IMC) 0609, we intend to complete our evaluation using the best available information and issue our final determination of safety significance within 90 days from such initial communication on February 28, 2007.

Because the finding was determined to be of very low safety significance for Unit 2 and because it is entered into your corrective action program, the NRC is treating the finding for Unit 2 as a non-cited violation (NCV) consistent with Section VI.A.1 of the NRC Enforcement Policy. If you contest the NCV in this report, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the U.S. Nuclear Regulatory Commission, ATTN.: Document Control Desk, Washington, DC 20555-0001; with copies to the Regional Administrator, Region II; the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; and the NRC Resident Inspector at the Brunswick Steam Electric Plant. The current Enforcement Policy is included on the NRC's Web site at http://www.nrc.gov/what-we-do/regulatory/enforcement/enforce-pol.html.

The SDP encourages an open dialogue between the staff and the licensee; however, the dialogue should not impact the timeliness of the staff's final determination. Before we make a final decision on this matter, we are providing you an opportunity (1) to present to the NRC your perspectives on the facts and assumptions used by the NRC to arrive at the finding and its significance, at a Regulatory Conference or (2) to submit your position on the finding to the NRC in writing. If you request a Regulatory Conference, it should be held within 30 days of the date of receipt of this letter and we encourage you to submit supporting documentation at least one week prior to the conference in an effort to make the conference more efficient and effective. If a Regulatory Conference is held, it will be open for public observation and the NRC will issue a press release to announce the conference. If you decide to submit only a written response, such submittal should be sent to the NRC within 30 days of the receipt of this letter.

Please contact Mr. Randall Musser at (404) 562-4603 within 10 business days of the receipt of this letter to notify the NRC of your intentions regarding the regulatory conference for the preliminary White finding. If we have not heard from you within 10 days, we will continue with our significance determination and associated enforcement processes on this finding, 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, a Notice of Violation is not being issued for the inspection finding at this time. In addition, please be advised that the number and characterization of the AV described in the NRC Inspection Report No.05000325, 324/2007008 may change as a result of further NRC review.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter and your response (if any) 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/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

Charles A. Casto, Director
Division of Reactor Projects

Docket Nos.: 50-325, 50-324
License Nos: DPR-71, DPR-62

Enclosures:
1. NRC Inspection Report No. 05000325,324/2007008
   w/Attachment: Supplemental Information
2. Phase 3 SDP Risk Analysis and Related Attachments

document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

Charles A. Casto, Director
Division of Reactor Projects

Docket Nos.: 50-325, 50-324
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w/Attachment: Supplemental Information
2. Phase 3 SDP Risk Analysis and Related Attachments

*FOR PREVIOUS CONCURRENCE SEE ATTACHED SHEET

X PUBLICLY AVAILABLE X NON-SENSITIVE

ADAMS: X Yes ACCESSION NUMBER:_ML070590404__

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NAME	*CEvams:rcm	*RMusser	EDipaolo	*SNinh	*RBernhard	*RPascarelli	*DSolorio
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Report to James Scarola from Charles A. Casto dated February 28, 2007

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U. S. NUCLEAR REGULATORY COMMISSION

REGION II

Docket Nos:	50-325, 50-324
License Nos:	DPR-71, DPR-62
Report Nos:	05000325/2007008 and 05000324/2007008
Licensee:	Carolina Power and Light (CP&L)
Facility:	Brunswick Steam Electric Plant, Units 1 & 2
Location:	8470 River Road SE Southport, NC 28461
Dates:	February 4 through 28, 2007
Inspectors:	E. DiPaolo, Senior Resident Inspector S. Ninh, Senior Project Engineer
Approved by:	Randall A. Musser, Chief Reactor Projects Branch 4 Division of Reactor Projects

Enclosure 1

SUMMARY OF FINDINGS

IR 05000325/2007008, 05000324/2007008; 02/04/07 - 02/28/07; Brunswick Steam Electric Plant, Units 1 and 2; Event Followup.

This in-office review was conducted by a regional senior project engineer and the senior resident inspector at Brunswick. A preliminary White finding and an apparent violation was identified for Unit 1 and one Green non-cited violation (NCV) was identified for Unit 2. The significance of most findings is indicated by their color (Green, White, Yellow, Red) using Inspection Manual Chapter (IMC) 0609, “Significance Determination Process” (SDP). Findings for which the SDP does not apply may be Green or be assigned a severity level after NRC management review. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, “Reactor Oversight Process,” Revision 3, dated July 2000.

A. NRC-Identified and Self-Revealing Findings

Cornerstone: Mitigating Systems

TBD. A preliminary White finding with an apparent violation (AV) of Technical Specification (TS) 3.8.1, AC Sources-Operating, was identified for Unit 1. The finding involved inadequate corrective actions to prevent a repeat failure of the #9 main crankshaft bearing on EDG #1, a failure to follow the foreign material exclusion control procedure during maintenance performed on EDG #1, and the failure to promptly identify and implement adequate actions to prevent emergency diesel generator (EDG) #1 from tripping on low lubricating oil pressure. The finding was determined to be a Green non-cited violation for Unit 2. The difference in risk significance between the units is due to differences in electric bus loads. This finding has a cross-cutting aspect in the area of Problem Identification and Resolution, in that lubricating oil strainer high differential pressure due to clogging by fibrous lint material was not promptly identified as a condition adverse to quality in a timely manner commensurate with the potential safety significance.

This finding is more than minor because it is associated with the availability and reliability of EDG #1 to mitigate events such as a loss of offsite power (LOOP) and primarily affected the Mitigating System Cornerstone for Units 1 and 2. Because the finding also affected the Initiating Events Cornerstone (i.e., LOOP with Loss of One AC Division) and represented an actual loss of safety function of EDG #1 for greater than the TS allowed outage time for one EDG (i.e., seven days), a Significance Determination Process Phase 2 analysis was performed. The dominant core damage sequence in the Phase 2 was LOOP and LOOP with Loss of One AC Division. The results of the Phase 2 analysis required a Phase 3 evaluation. Phase 3 assessments for Units 1 and 2 were performed with the assumption that EDG # 1 was out of service for 130 hours. The Phase 3 analysis results for the internal event initiators calculated a change in Core Damage Frequency (delta CDF) of 1.3E-6 / year for Unit 1 and CDF of

1.57E-7 for Unit 2. In addition, evaluation of external event initiators and large early release frequency (LERF) for both units did not change the color. The finding is of low to moderate safety significance (White) for Unit 1, and is of very low safety significance (Green) for Unit 2.

B. Licensee Identified Violations

None

4. OTHER ACTIVITIES

Cornerstone: Mitigating Systems

4OA3 Event Follow-up

.1 (Closed) Unresolved Item (URI) 05000325,324/2006005-01, Trip of EDG #1 and Failure of Engine Crankshaft Bearing

a. Inspection Scope

The inspectors reviewed the Unit 2 loss of startup auxiliary transformer event on November 1, the trip of EDG #1 and failure of engine crankshaft bearing events on November 2, 2006. The inspectors reviewed the TS, plant procedures, recent and past maintenance activities on EDG #1 to determine whether EDG #1 problems were promptly identified and the licensee's corrective actions were adequately implemented to prevent EDG #1 trip on low lubricating oil pressure and to prevent a failure of the #9 main crankshaft bearing. This URI was opened for additional inspection to resolve this issue.

b. Findings

Introduction.

A preliminary White finding and one AV of TS 3.8.1, AC Sources-Operating was identified for Unit 1. The finding was associated with inadequate actions to prevent a repeat failure of the #9 main crankshaft bearing on EDG #1, a failure to follow the foreign material exclusion controls procedure during maintenance performed on EDG #1, and the failure to promptly identify and implement adequate actions to prevent EDG #1 from tripping on low lubricating oil pressure. This finding was identified as a Green NCV for Unit 2.

Description.

On November 1, 2006 at 1823, Unit 2 was manually scrammed as a result of a loss of offsite power caused by a lockout of the Startup Auxiliary Transformer. EDGs #3 and #4 automatically started and re-energized emergency buses E3 and E4 which were affected by the loss of offsite power. EDGs #1 and #2 also automatically started but did not tie to their respective buses (E1 and E2) as the buses remained powered from the Unit 1 Unit Auxiliary Transformer. At approximately 0400 on November 2, EDG #1 tripped on low lubricating oil pressure. Prior to the EDG tripping, high lubricating oil strainer differential pressure alarms were received on both filter elements of the system's duplex strainer. Maintenance personnel dispatched to clean one of the strainers found that the high differential pressure was caused by clogging fibrous lint material. EDG #1 tripped when operators were shifting lubricating system flow to a newly cleaned strainer.

The licensee found that the strainer filter elements also contained engine bearing material along with the fibrous lint material. Corrective maintenance on EDG #1 later found the engine's #9 main crankshaft bearing had failed. Failure analysis of the bearing concluded that the exact cause of the failure could not be determined with certainty. The analysis of the aluminum-backed bearing supported the conclusion that the bearing experienced a loss of bearing-to-housing clamping force. When journal bearings are assembled, each bearing insert is installed in a semi-circular bore in the bearing housing and a similar area of the bearing cap. When assembled into the cap and the housing section, the ends of the inserts stick out slightly. When the cap is put in position, the ends of the bearing inserts butt up against one another before the cap actually seats against the block. In this position, the inside diameter of the bearing will be slightly greater when measured between the centers of the inserts than when measured between the two ends of either insert. The difference between these two diameters is the bearing crush. The crush is removed when the main cap bolts are tightened to their specified torque. This results in a clamping force on the bearing which is essential for heat transfer and to eliminate relative motion between the bearing and bearing housing or cap.

The licensee's failure analysis concluded that the bearing lost effective lubrication and the surface of the bearing was wiped. Inspections performed discovered a cleaning towel, that was apparently used during the performance of recent maintenance outage, in the suction strainer of the engine-driven lubricating oil pump. Following repairs, the licensee declared EDG #1 operable on November 7.

Bearing #9 failed in a similar manner in 1992. During scheduled maintenance the bearing was found to be broken on the lower half of the bearing and wiped. The licensee concluded that the most probable cause was the installation of a bearing shell manufactured with a lack of the designed interference "crush" between the bearing shell halves and their housing. The licensee also noted that the clearance of the installed main crankshaft bearings on EDG #1 were larger than the original manufacturer recommendations. The cause of the larger clearances was unknown, and is still unknown. The larger clearance may be a result of manufacturing differences on the bore of the main crankshaft bearing housings or past operational occurrences on the EDG. The licensee established acceptability of the larger clearances following the 1992 failure (Engineering Evaluation Report 92-0380). Repairs were made to the engine and the EDG was restored to service. No actions to address the larger clearances on EDG #1 were taken at that time.

The licensee concluded that the November 2, 2006 bearing failure was caused by the increased main crankshaft bearing clearances which results in lower initial crush and greater operational stresses on the bearings. The EDG's manufacturer (Nordberg) issued a service bulletin (Bulletin 72:3) in June of 1972 addressing engine bearing service life. During discussions with the EDG system engineer, the inspectors were informed that the licensee was not aware of the service bulletin until the November 2, 2006 EDG failure. The bulletin explained that dirt and metallic debris in engine lubricating oil systems tend to shorten the service life of aluminum bearings. Aside from the wear, the foreign material causes operating temperatures to increase which may result in the aluminum shell yielding, causing the bearings to lose their "crush" in a relatively short number of operating hours. Loss of "crush" or loose bearing shells result in fretting of the bearing backs, loss of heat transfer to the housing and loss of bearing geometry. The bulletin contained recommendations to assure maximum service life. These included maintaining the cleanliness of the lubricating oil and procedures for monitoring and ensuring the performance of aluminum bearings. This included a method to measure bearing crush. The inspectors concluded that the licensee's corrective actions following the 1992 bearing failure were inadequate to prevent the recurrence of failure of the #9 main crankshaft bearing.

The inspectors concluded that the #9 crankshaft bearing failure on November 2, 2006 may have been due to various factors. These factors included reduced bearing crush, due to increased main crankshaft bearing clearances, and elevated bearing operating temperature due to low lubricating oil pressure, foreign material, or high lubricating oil temperature caused by the presence of the cleaning towel in the lubricating oil system. Regardless of how much of a contribution the cleaning towel had on the cause of the bearing failure, the inspector concluded that the primary cause of the EDG #1 low lubricating oil trip on November 2 was due to the duplex strainer filter element clogging by material from the cleaning towel that was inadvertently left in the engine crankcase following maintenance. The inspectors noted that the low lubricating oil trip remains in effect during EDG actuation in response to an emergency core cooling initiation signal.

The inspectors reviewed recent maintenance activities on EDG #1. On October 23, 2006, the licensee removed EDG #1 from service to facilitate scheduled preventive maintenance per Maintenance Surveillance Test 0MST-DG501R3, Emergency Diesel Generators 72 Month Inspection, Revision 17. During the performance of the maintenance, open engine crankcase and lubricating oil sump activities were performed. Cleaning of engine internals/removal of residual oil was performed with the use of fibrous towels. The foreign material exclusion (FME) controls used during these activities was determined to be Moderate per Nuclear Generation Group Standard Procedure MNT-NGGC-0007, Foreign Material Exclusion Program, based on the presence of any FME being readily detectable. The licensee's root cause evaluation concluded that the controls were inadequate because the engine crankcase contained areas where the presence of foreign material cannot be readily detected (i.e., engine lubricating oil pump suction header). Based on this, the FME area classification for the engine crankcase should have been High and therefore subject to more stringent controls.

Following the performance of the scheduled maintenance and other emergent activities, EDG #1 post-maintenance operational testing was performed. During two maintenance operational tests, one on October 27 and one on October 29, lubricating oil strainer high differential alarms were received. Cleaning of the strainers revealed that the high differential pressures were caused by a buildup of fibrous lint material in the strainer. No further corrective actions were taken at the time. Subsequently, EDG #1 was declared operable on October 30, 2006.

Analysis.

The inspectors determined that on November 2, 2006, EDG #1 experienced a preventable trip on low lubricating oil pressure and a preventable failure of the #9 main crankshaft bearing as demonstrated by the following:

The licensee's corrective actions following a failure of the same #9 main crankshaft bearing in 1992 were inadequate to prevent recurrence. During repairs of the bearing in 1992, the licensee noted that the clearance of the installed crankshaft bearings were larger on EDG #1 than the original manufacturer recommendations. No actions to address the larger clearances, which results in less initial bearing crush, were taken at that time.

The licensee failed to implement proper foreign material exclusion controls during maintenance activities on EDG #1 between October 23-30, 2006, which resulted in EDG #1 being returned to service with a cleaning towel in the engine's lubricating oil system. During the maintenance activities, the licensee implemented only "Moderate" foreign material exclusion controls in lieu of the required "High" controls required by plant procedures.

The licensee failed to identify a condition adverse to quality when lubricating oil system strainer clogging by engine cleaning towel material was experienced during maintenance runs on October 27 and 29, 2006. During post maintenance testing of EDG #1 following maintenance activities discussed above, lubricating oil strainer high differential pressure alarms were received. Cleaning of the strainers revealed that the condition was the result of a buildup of fibrous lint material in the strainer. The strainers were cleaned, however, no further investigation or corrective actions were taken, and the EDG was declared operable on October 30, 2006.

These conditions ultimately resulted in the trip of EDG #1 and bearing failure on November 2, 2006 during the Unit 2 loss of offsite power event. As a result, EDG #1 was in an inoperable and nonfunctional condition for a time period greater than allowed by the Unit 1 TS from October 30 through November 7, 2006.

This finding is more than minor because it is associated with the availability and reliability of EDG #1 to mitigate events such as a LOOP and primarily affected the Mitigating System Cornerstone for Units 1 and 2. Because the finding also affected the Initiating Events Cornerstone (i.e., LOOP with Loss of One AC Division) and represented an actual loss of safety function of EDG #1 for greater than the TS allowed outage time for one EDG (i.e., seven days), a Significance Determination Process Phase 2 analysis was performed. The dominant core damage sequence was LOOP and LOOP with Loss of One AC Division. The results of the Phase 2 analysis required a Phase 3 evaluation.

The Phase 3 evaluation is summarized as follows:

ASSUMPTIONS:

1. The Brunswick SPAR model was modified to update failure data that has not yet been included in the most recent release.

2. The SDP process is based on average availability and condition of the plant and equipment, with the exception of the specific performance deficiency. For this analysis, the average Unit 2 condition is at power with the normal likelihood of all initiators. The actual condition involved a loss of offsite power on Unit 2 during the period when EDG #1 was degraded.

3. The exact condition and response of EDG #1 prior to its bearing failure is unknown. It ran for a period of time prior to the failure, but the EDG was not fully loaded. For the purposes of this analysis, the period of time the EDG was being repaired was used as the primary time of consideration for this SDP. During the repair, its condition is known. It was not available. A bounding case was then run for the exposure period prior to bearing failure to determine if inclusion of this time would result in a color change in the SDP results. Exposure Time - 130 hours for the repair, and another 81 hours of exposure with a degraded EDG.

4. Common cause failure of the other EDGs for the same reason is excluded because of the run times the other EDGs have had since their last maintenance. EDG #1 has physical characteristics that led to the bearing crush problem, and the other machines are not susceptible. Common cause was set to its nominal value for the runs, so other forms of common cause are reflected. Separate runs were made for a sensitivity to determine the impact if common cause was assumed.

SUMMARY OF CALCULATIONS:

PRA Model used for basis of the risk analysis: Modified Brunswick SPAR.
Significant Influence Factor(s) [if any]: Duration of each condition drives the risk.

The calculations were made to reflect risk as if the condition existed for one year. The results were then be scaled back to reflect the assumed time the condition existed. First the impact of the EDG out for maintenance will be calculated. For this period of time the EDG is known to be unavailable, and other important equipment will not be taken out of service for maintenance, as defined by the recovery rules in the model.

Setting the EDG #1 to maintenance for 8760 hours (one year) results in a change in CDF of 9.0E-5/year. Dominant sequences involve loss of an AC or DC bus, along with the failure of the transfer from the UAT to the SAT, resulting in a loss of offsite power, and loss of the secondary cooling. If the operators fail to align the power to an alternate source, the batteries eventually discharge without their chargers, the high pressure systems fail without DC power, and core damage results. The dominant loss of DC sequence directly takes away control power to the breakers performing the fast transfer to offsite power. One MSIV in each line closes, giving a reactor trip. Secondary side makeup recovery is limited, because control power to the condensate pumps comes from the battery. The utility has a failure rate about an order of magnitude lower than the SPAR model for the failure to cross tie the power. The Loss of Offsite Power Sequences involve failure of the other EDG through diesel failures or through failure of the support systems. Absent an operator action to crosstie to an available bus from Unit 2, the batteries discharge, high pressure injection fails without DC, and core damage results.

A one year exposure for Unit 2 was calculated to be 1.0E-5, if Unit 2 was assumed to be at power. The calculation was performed by using the available Unit 1 model, and setting EDG #4 in Maintenance. EDG #4 was chosen to more closely model the symmetry of the Unit 2 power configuration to the low pressure injection systems. The results are dominated by Loss of Offsite Power sequences that are the same as the LOOP sequences for Unit 1. Unit 2 was actually shutdown for part of this time, but the SDP requires the evaluation to be at the average condition of the plant.

Calculations were then performed to allow a screening to be made for the period of time the oil rag was in the sump, and the reliability of the equipment is uncertain. Since the licensee was unaware of the condition, other important equipment could be taken out during this time for maintenance. To obtain an upper bound, calculations were performed assuming no common cause link for the performance deficiency to the other EDGs, and for a sensitivity, and another run was performed to reflect common cause. The fail to run of the equipment was set to TRUE. This would reflect an early failure of the machine, which did not happen. The machine ran for many hours prior to the EDG trip, but was in a lightly loaded condition, which would not reflect accident loads. The dominant sequences were much the same as for the maintenance results. For the common cause runs, common cause failures of the other machine contribute to the results. The results are summarized below:

	Maintenance	Fail to Run w/o common cause	Fail to Run with common cause
Unit 1	9.0E-5/yr	9.9E-5/yr	1.2E-4/yr
Unit 2	1.0E-5/yr	1.1E-5/yr	1.4E-5/yr

DELTA CDF FOR EXPOSURE TIME

The exposure time can be broken down into two intervals. The first is when the rag was included in the sump starting with the lifting of the clearances on the EDG just prior to the successful maintenance run (10/29/06 1856 hours), up until the time the machine tripped while in service (11/2/06 0400 hours). During this 81 hour period, the status of the machine is suspect. The machine did run unloaded, or on minimal load for hours prior to its failure, however its ability to operate at full load is uncertain.

The second interval is the period of time the machine is not available due to it being under repair. For this period, the EDG would have been unable to perform its function. This period ran from 11/2/06 at 0400 hours until the machine had the clearances lifted just prior to its successful maintenance run at 1355 hours on 11/7/06. This is 130 hours.

Adjusting the above result for the time interval results in:

	Maintenance	Fail to Run w/o common cause	Fail to Run with common cause
Hours	130	81	81
Unit 1	1.3E-6	9.2E-7	1.1E-6
Unit 2	1.5E-7	1.0E-7	1.3E-7

For the interval for which we have certain knowledge of the state of the EDG, the risk is 1.3E-6 for Unit 1, and 1.5E-7 for Unit 2. This exceeds the threshold for Unit 1, and is at least a WHITE finding. Unit 2 is GREEN.

Conservatively assuming the EDG will fail early in its run if challenged during the period of time the knowledge of machine performance is in question, and adding the fail to run probabilities to the results from the maintenance period, the results almost double, but the colors do not change.

EXTERNAL EVENTS CONSIDERATIONS:

Brunswick's frequency of occurrence of a 300 cm/sec/sec earthquake is 6.6E-5/yr. This .3g earthquake is considered to be large enough to break the ceramic insulators in the switchyard, leading to a LOOP. Based on data from NUREG-1488, "Revised Livermore Seismic Hazard Estimates for Sixty-Nine Nuclear Power Plant Sites East of the Rocky Mountains", an estimate can be obtained for the additional LOOP contribution due to earthquakes. This additional contribution to the LOOP frequency (~.3%) is not enough to impact the calculation in a significant manner.

Flood impact is minimal. Turbine building flood that could impact the Unit Boards is minimized because of flood barriers around the unit boards, and flood sensors that trip the circulating water pumps in the event of a circulating water piping or condenser water box failure. Floods that can impact the EDG building would also impact the EDG with the finding, so the change is negligible. Review of the IPE internal flood section did not reveal any major impact that should be considered.

Fire impact insights can be gained by determining the fire initiator frequencies for the areas that mimic the initiators in the internal events model and using them in a screening analysis. Areas of interest are:

> Transformer fires leading to LOOP is about 1.6E-3 / year for the site (EPRI FIVE, Table 1.2) for each transformer.
>
> Fire ignition frequency in the Control Room for the XU5 panel (that is the panel that if damaged could result in a LOOP) is 9E-5/ year. Control room fire initiator is 9.7E-3 and the likelihood of requiring control room evacuation is 1.6E-2 (IPEEE). If you assume that evacuation will lead to total destruction of all panels the fire adds (9.7E-3 * 1.6E-2) or 1.6E-4 to the 9E-5 for the specific panel damage for a total of 2.5E-4/yr for a control room fire that impacts XU5 and loss of offsite power.
>
> Cable Spread Room initiators are going to be about 6E-3 /yr (Brunswick IPEEE).
>
> The entire Turbine Building is 7.5E-2 /yr(IPEEE).
>
> Loss of a DC battery about 3.2E-3/yr (EPRI)
>
> Loss of an Emergency Bus about 5E-3 /yr (EPRI).

The initiators used in the SPAR model for internal events were loss if1BDC at about 1.2E-3/yr, Loss of the AC bus at about 2E-2 / yr. And loss of offsite power at 3.5E-2/yr.

The fire risk from a Loss of DC battery due to fire is about 4 times the internal initiator number. The annual contribution from the loss of DC sequences without the EDG is about 4.2E-5. Scaling this result:

> 4.2E-5/yr / 1.2E-3/yr = CCDP for DC = 3.8E-2
> 3.8E-2 * 3.2E-3/yr = 1.2E-4/ yr or 1.7E-6 for a 130 hour exposure period.

The loss of AC fire initiators total 8.3E-2 by combining the direct LOOP contributors (transformer, turbine building, XU5 panel, cable spread room). This is without credit for suppression in the areas outside the control room. This is about 4 times greater than the internal model's LOOP frequency. The contribution per year for LOOP given the loss of an EDG is about 2.3E-5/yr. Scaling the result:

> 2.5E-5/yr / 3.5E-2/yr = CCDP for LOOP = 7.1E-4
> 7.1E-4 * 8.3E-2/yr = 5.9E-5/yr or about 8.8E-7 for the 130 hour exposure period.

If the suppression was credited, and the fraction of the building that a fire could cause a LOOP were credited the answer would drop by over an order of magnitude.

The fire risk from loss of AC bus is 5E-3. The contribution from LOAC Bus E2 and the EDG out of service for one year is about 2.1E-5. Scaling the result:

2.1E-5/yr / 2E-2/yr = CCDP for LOACE2 = 1.1E-3

1.1E-3 * 5E-3/yr = 5.5E-6/yr or about 8E-8 for the exposure period

Adding together the external initiators and fire screening values gives about 2.7E-6 for the exposure period for the impact of increased initiating event frequencies due to external and fire. This is not enough to change the color of the Unit 1 finding. In addition, for many fires resulting in LOOP, the other units offsite power is available for crosstie. For Unit 2 impact the result will be less than the proportional impact for Unit 1, because the loss of DC sequences don't have the impact. Unit 2 did not change color.

LARGE EARLY RELEASE FREQUENCY IMPACT:

Because Brunswick has a concrete lined torus, its multiplier for LERF sequences is .1, and the LERF impact is the same as the CDF impact in the SDP.

PHASE 3 CONCLUSIONS/RECOMMENDATIONS :

Risk increase over the base case was > 1E-6, and the finding is WHITE for Unit 1. Unit 2 has a GREEN result. A copy of the dominant SPAR sequences is attached for the Unit 1 evaluation for the period of time the EDG was out of service.

This finding has a cross-cutting aspect in the area of Problem Identification and Resolution, in that lubricating oil strainer high differential pressure due to clogging by fibrous lint material was not promptly identified as a condition adverse to quality in a timely manner commensurate with the potential safety significance.

Enforcement.

10CFR50, Appendix B, Criteria XVI (Corrective Action) requires in part, that measures shall be established to assure that conditions adverse to quality, such as deviations, are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition.

TS 5.4.1, Administrative Controls (Procedures), require that written procedures shall be implemented covering applicable procedures recommended in Regulatory Guide 1.33, Appendix A, November 1972. Regulatory Guide 1.33 requires written procedures for the control of maintenance and repair. Nuclear Generation Group Standard Procedure MNT-NGGC-0007, Foreign Material Exclusion Program, Revision 6, Attachment A, Foreign Material Exclusion Area Classification Matrix, requires High Foreign Material Exclusion Controls when working on open systems and component when foreign material cannot be readily detected.

TS 3.8.1, AC Sources-Operating, requires four EDGs to be operable when in Mode 1, and allows operation with three operable EDGs for a period of seven days.

Contrary to the above, licensee corrective actions following the failure of the #9 main crankshaft bearing on EDG #1 in 1992, a significant condition adverse to quality, were not adequate to preclude a repeat failure of the bearing on November 2, 2006. High Foreign Material Controls were not instituted during open maintenance activities on the engine crankcase and lubricating oil sump, which contain areas where foreign material would be difficult to detect, on EDG #1 between October 23-30, 2006. Lubricating oil system strainer clogging by pieces of an engine cleaning towel, as indicated by high differential pressure alarms experienced during maintenance runs on October 27 and 29, 2006, was not promptly identified as a condition adverse to quality. As a result, additional lubricating oil strainer clogging occurred, due to the presence of an engine cleaning towel left in the engine's lubricating oil system following a maintenance outage, during EDG #1 operation on November 2, 2006. This resulted in the tripping of the EDG on low lubricating oil pressure during a Unit 2 LOOP event. As a result, while Unit 1 was in Mode 1, only three EDGs were operable from October 30 until November 7, 2006, and the requirements of TS 3.8.1, AC Sources-Operating, were not satisfied.

This finding does not present a current safety concern because the EDG was repaired and restored to an operable status on November 7, 2006. This issue has been entered into the licensee's Corrective Action Program (CAP) as AR 211236. This self-revealing finding and AV of regulatory requirements is identified for Unit 1 as AV 05000325/2007008-01, Failure to Meet TS 3.8.1, AC Sources-Operating.

Because the failure to identify the adverse condition is of very low safety significance for Unit 2 and has been entered into the CAP, this finding is being treated as an NCV, consistent with Section VI.A of the Enforcement Policy: NCV 05000324/2007008-02, Failure to Identify Adverse Condition with EDG Lubricating Oil System.

4OA6 Management Meeting

Exit Meeting Summary

The resident inspectors presented the inspection results to Mr. Scarola and other members of licensee management at the conclusion of the inspection on February 28, 2007. The inspectors asked the licensee whether any of the material examined during the inspection should be considered proprietary. The licensee did not identify any proprietary information.

ATTACHMENT: SUPPLEMENTAL INFORMATION

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee personnel

J. Scarola, Site Vice President
B. Waldrep, Plant General Manager

NRC personnel

R. Musser, Chief, Reactor Projects Branch 4, Region II
E. DiPaolo, Senior Resident Inspector, Brunswick

LIST OF ITEMS OPENED, CLOSED AND DISCUSSED

Opened

05000324/2007008-01	AV	Failure to Meet TS 3.8.1, AC Sources-Operating (Section 4OA3)

Opened and Closed

05000325/2007008-02	NCV	Failure to Identify Adverse Condition with EDG Lubricating Oil System (Section 4OA3)

Closed

05000325,324/2006005-01	URI	Trip of EDG #1 and Failure of Engine Crankshaft Bearing (Section 4OA3)

SPAR output - EDG #1 out of service for one year

Code Version: 7:26		Model Version	: 2007/01/11
Project	: BRUN_332	Duration (hrs)	: 8.8E+003
User Name	: EG&G IDAHO, INC. (INEL)	Total CCDP	: 1.1E-004
Event ID	: EDG-NO-1-MX	Total CDP	: 1.5E-005
		Importance	: 9.0E-005

Description : Condition Assessment

BASIC EVENT CHANGES

Event Name	Description	Base Prob	Curr Prob	Type
EPS-DGN-TM-DG1	DIESEL GENERATOR 1 UNAVAILAB	1.2E-002	1.0E+000	TRUE
EPS-DGN-TM-DG2	DIESEL GENERATOR 2 UNAVAILAB	1.2E-002	+0.0E+000	

SEQUENCE PROBABILITIES

Truncation : Cumulative : 100.0% Individual : 0.0%

Event Tree Name	Sequence Name	CCDP	CDP	Importance
LODC1B	43	3.3E-005	1.8E-006	3.1E-005
LOAC-E2	43	2.3E-005	1.5E-006	2.1E-005
LOOP	32-07	1.7E-005	1.4E-006	1.6E-005
LODC1B2	43	7.4E-006	5.2E-007	6.9E-006
TRANS	43	2.9E-006	2.4E-007	2.6E-006
LOOP	29	2.6E-006	3.2E-007	2.3E-006
LODC1B2	20	2.3E-006	1.2E-007	2.1E-006
LOOP	13	1.9E-006	1.0E-007	1.8E-006
LOOP	32-16	1.6E-006	1.3E-007	1.5E-006
LODC1B2	42	1.3E-006	7.1E-008	1.3E-006

NEGATIVE SEQUENCE PROBABILITIES

Truncation : Cumulative : 100.0% Individual : 0.0%

Event Tree Name	Sequence Name	CCDP	CDP	Importance

NOTE: Percent contribution to total Importance.

SEQUENCE LOGIC

Event Tree	Sequence Name	Logic	
LODC1B	43	/RPS	PCS
		/SRV-O	/SRV
		HPI	DEP

Enclosure 2

LOAC-E2	43	/RPS /SRV-O HPI	PCS /SRV DEP
LOOP	32-07	/RPS /SRV BX AC-02H	EPS /RCI DEP
LODC1B2	43	/RPS /SRV-O HPI	PCS /SRV DEP
TRANS	43	/RPS /SRV-O HPI	PCS /SRV DEP
LOOP	29	/RPS /SRV DEP	/EPS HPI
LODC1B2	20	/RPS /SRV-O /HPI /DEP LPI	PCS /SRV SPC CDS VA
LOOP	13	/RPS /SRV SPC LPI	/EPS /HPI /DEP VA
LOOP	32-16	/RPS /SRV HCI	EPS RCI AC-30M
LODC1B2	42	/RPS /SRV-O HPI CDS VA	PCS /SRV /DEP LPI

Fault Tree Name	Description
AC-02H	AC POWER RECOVERY IN 2 HRS
AC-30M	Developed Event
BX	4160 V BUS CROSS-TIE
CDS	CONDENSATE
DEP	MANUAL REACTOR DEPRESS
EPS	EMERGENCY POWER
HCI	HPCI

HPI	HIGH PRESSURE INJECTION
LPI	LOW PRESSURE INJECTION (CS or LPCI)
PCS	POWER CONVERSION SYSTEM
RCI	RCIC
RPS	REACTOR SHUTDOWN
SPC	SUPPRESSION POOL COOLING
SRV	SRV'S CLOSE
SRV-O	PRESSURE RELIEF
VA	ALTERNATE LOW PRESS INJECTION

SEQUENCE CUT SETS

Truncation: Cumulative: 100.0% Individual: 1.0%

Event Tree: LODC1B CCDF: 3.3E-005
Sequence: 43

CCDF	% Cut Set	Cut Set Events	
3.0E-005	91.01	DCP-XHE-XA-ALTDC	
1.5E-006	4.55	ACP-CRB-OO-ALT1D	
1.5E-006	4.55	ACP-CRB-CC-NORM1D	

Event Tree: LOAC-E2 CCDF: 2.3E-005
Sequence: 43

CCDF	% Cut Set	Cut Set Events	
1.1E-005	49.19	ACP-CRB-CC-NORM1D	
1.1E-005	49.19	ACP-CRB-OO-ALT1D	

Event Tree: LOOP CCDF: 1.7E-005
Sequence: 32-07

CCDF	% Cut Set	Cut Set Events	
1.6E-006	9.33	OPR-XHE-XM-DIVXT	EPS-XHE-XL-NR02H
		OEP-XHE-XL-NR02H	EPS-DGN-FR-DG2
		EPS-DGN-XX-R2H	
1.5E-006	8.71	OPR-XHE-XM-DIVXT	EPS-XHE-XL-NR02H
		OEP-XHE-XL-NR02H	EPS-DGN-FS-DG2
1.4E-006	8.27	OPR-XHE-XM-DIVXT	EPS-XHE-XL-NR02H
		OEP-XHE-XL-NR02H	EPS-FAN-FR-DG2EXHF
8.9E-007	5.22	OPR-XHE-XM-DIVXT	EPS-XHE-XL-NR02H
		OEP-XHE-XL-NR02H	EPS-FAN-FS-DG2EXH
7.4E-007	4.35	OPR-XHE-XM-DIVXT	EPS-XHE-XL-NR02H
		OEP-XHE-XL-NR02H	ACP-CRB-CC-NORM_E2
4.9E-007	2.87	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FR-DG2	EPS-DGN-FR-DG4
		DUAL-UNIT-LOOP	EPS-DGN-XX-R2H

4.9E-007	2.87	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FR-DG2	EPS-DGN-FR-DG3
		DUAL-UNIT-LOOP	EPS-DGN-XX-R2H
4.6E-007	2.68	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FS-DG2	EPS-DGN-FR-DG4
		DUAL-UNIT-LOOP	
4.6E-007	2.68	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FS-DG2	EPS-DGN-FR-DG3
		DUAL-UNIT-LOOP	
4.3E-007	2.55	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FR-DG4	DUAL-UNIT-LOOP
		EPS-FAN-FR-DG2EXHF	
4.3E-007	2.55	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FR-DG3	DUAL-UNIT-LOOP
		EPS-FAN-FR-DG2EXHF	
3.0E-007	1.74	OPR-XHE-XM-DIVXT	EPS-XHE-XL-NR02H
		OEP-XHE-XL-NR02H	EPS-PND-CC-DG2AA
3.0E-007	1.74	OPR-XHE-XM-DIVXT	EPS-XHE-XL-NR02H
		OEP-XHE-XL-NR02H	EPS-PND-CC-DG2BD
2.8E-007	1.63	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FR-DG2	EPS-DGN-TM-DG3
		DUAL-UNIT-LOOP	EPS-DGN-XX-R2H
2.8E-007	1.63	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FR-DG2	EPS-DGN-TM-DG4
		DUAL-UNIT-LOOP	EPS-DGN-XX-R2H
2.7E-007	1.61	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FR-DG3	DUAL-UNIT-LOOP
		EPS-FAN-FS-DG2EXH	
2.7E-007	1.61	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FR-DG4	DUAL-UNIT-LOOP
		EPS-FAN-FS-DG2EXH	
2.6E-007	1.52	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FS-DG2	EPS-DGN-TM-DG3
		DUAL-UNIT-LOOP	
2.6E-007	1.52	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FS-DG2	EPS-DGN-TM-DG4
		DUAL-UNIT-LOOP	
2.5E-007	1.44	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-TM-DG4	DUAL-UNIT-LOOP
		EPS-FAN-FR-DG2EXHF	
2.5E-007	1.44	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-TM-DG3	DUAL-UNIT-LOOP
		EPS-FAN-FR-DG2EXHF	
2.3E-007	1.34	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FR-DG3	DUAL-UNIT-LOOP
		ACP-CRB-CC-NORM_E2	
2.3E-007	1.34	EPS-XHE-XL-NR02H	OEP-XHE-XL-NR02H
		EPS-DGN-FR-DG4	DUAL-UNIT-LOOP
		ACP-CRB-CC-NORM_E2	

Event Tree: LODC1B2 CCDF: 7.4E-006
Sequence: 43

CCDF	% Cut Set	Cut Set Events	
6.0E-006	81.01	DCP-XHE-XA-AC_DC	
6.4E-007	8.58	EPS-DGN-FR-DG2	DCP-XHE-XA-ALTDC
1.5E-007	2.03	EPS-DGN-FS-DG2	DCP-XHE-XA-ALTDC
1.4E-007	1.92	DCP-XHE-XA-ALTDC	EPS-FAN-FR-DG2EXHF
9.0E-008	1.22	DCP-XHE-XA-ALTDC	EPS-FAN-FS-DG2EXH
7.5E-008	1.01	DCP-XHE-XA-ALTDC	ACP-CRB-CC-NORM_E2

Event Tree: TRANS CCDF: 2.9E-006
Sequence: 43

CCDF	% Cut Set	Cut Set Events	
9.6E-007	33.48	DCP-BCH-LP-1B2	DCP-XHE-XA-AC_DC
3.8E-007	13.39	DCP-BAT-LP-1B2	DCP-XHE-XA-AC_DC
1.1E-007	3.69	EPS-DGN-FR-DG2 ACP-CRB-OO-ALT1D	ACP-CRB-OO-ALT1C
1.1E-007	3.69	EPS-DGN-FR-DG2 ACP-CRB-CC-NORM1D	ACP-CRB-CC-NORM1C
1.1E-007	3.69	EPS-DGN-FR-DG2 ACP-CRB-OO-ALT1D	ACP-CRB-CC-NORM1C
1.1E-007	3.69	EPS-DGN-FR-DG2 ACP-CRB-OO-ALT1C	ACP-CRB-CC-NORM1D
1.0E-007	3.54	EPS-DGN-FR-DG2 DCP-XHE-XA-ALTDC	DCP-BCH-LP-1B2
9.6E-008	3.35	ACP-TFM-FC-E2E6	ACP-CRB-OO-ALT1D
9.6E-008	3.35	ACP-TFM-FC-E2E6	ACP-CRB-CC-NORM1D
7.7E-008	2.68	DCP-BDC-LP-1B2	DCP-XHE-XA-AC_DC
4.1E-008	1.42	DCP-BAT-LP-1B2 DCP-XHE-XA-ALTDC	EPS-DGN-FR-DG2

Event Tree: LOOP CCDF: 2.6E-006
Sequence: 29

CCDF	% Cut Set	Cut Set Events	
1.7E-006	66.40	ACP-TFM-FC-E2E6	
3.5E-007	13.28	ACP-BAC-LP-E6	
1.7E-007	6.64	DCP-BCH-LP-1B2	ACP-XHE-XA-E5E6
6.9E-008	2.66	DCP-BAT-LP-1B2	ACP-XHE-XA-E5E6
5.1E-008	1.97	ADS-TSW-FT-DC125 RCI-RESTART ACP-XHE-XA-E5E6	RCI-TDP-FS-RSTRT RCI-XHE-XL-RSTRT
4.3E-008	1.66	ADS-TSW-FT-DC125 ACP-XHE-XA-E5E6	RCI-TDP-TM-TRAIN
3.0E-008	1.16	ADS-TSW-FT-DC125 ACP-XHE-XA-E5E6	RCI-TDP-FS-TRAIN

Event Tree: LODC1B2 CCDF: 2.3E-006
Sequence: 20

CCDF	% Cut Set	Cut Set Events	
1.2E-006	53.11	OPR-XHE-XM-DIVXT13	DCP-XHE-XA-ALTDC
3.6E-007	15.93	RSW-MDP-TM-1A	DCP-XHE-XA-ALTDC
2.4E-007	10.62	DCP-XHE-XA-ALTDC	RHR-SYS-TM-A
4.5E-008	1.99	RHR-MDP-FS-1A	DCP-XHE-XA-ALTDC
4.5E-008	1.99	RSW-MDP-FS-1A	DCP-XHE-XA-ALTDC
3.6E-008	1.59	NSW-AOV-CC-V129	DCP-XHE-XA-ALTDC
3.6E-008	1.59	NSW-AOV-CC-V130	DCP-XHE-XA-ALTDC
3.0E-008	1.33	RSW-MOV-CC-F068A	DCP-XHE-XA-ALTDC
3.0E-008	1.33	DCP-XHE-XA-ALTDC	SPC-MOV-CC-28A
3.0E-008	1.33	DCP-XHE-XA-ALTDC	SPC-MOV-CC-24A
3.0E-008	1.33	RSW-MOV-CC-F002A	DCP-XHE-XA-ALTDC
3.0E-008	1.33	RSW-XHE-XR-MDP1A	DCP-XHE-XA-ALTDC
3.0E-008	1.33	RHR-MOV-CC-F007A	DCP-XHE-XA-ALTDC
3.0E-008	1.33	RHR-MOV-OO-F048A	DCP-XHE-XA-ALTDC
3.0E-008	1.33	RHR-XHE-XR-MDP1A	DCP-XHE-XA-ALTDC

Event Tree: LOOP CCDF: 1.9E-006
Sequence: 13

CCDF	% Cut Set	Cut Set Events	
1.7E-007	9.16	OPR-XHE-XM-DIVXT13	DCP-BCH-LP-1B2
1.3E-007	6.84	EPS-DGN-FR-DG3	EPS-DGN-FR-DG4
		LCS-MDP-TM-1B	
9.1E-008	4.85	EPS-DGN-FR-DG3	DCP-BCH-LP-1B2
7.3E-008	3.88	EPS-DGN-TM-DG3	EPS-DGN-FR-DG4
		LCS-MDP-TM-1B	
7.3E-008	3.88	EPS-DGN-FR-DG3	EPS-DGN-TM-DG4
		LCS-MDP-TM-1B	
6.9E-008	3.66	OPR-XHE-XM-DIVXT13	DCP-BAT-LP-1B2
5.2E-008	2.75	RSW-MDP-TM-1A	DCP-BCH-LP-1B2
5.2E-008	2.75	EPS-DGN-TM-DG3	DCP-BCH-LP-1B2
3.7E-008	1.94	DCP-BAT-LP-1B2	EPS-DGN-FR-DG3
3.5E-008	1.83	DCP-BCH-LP-1B2	RHR-SYS-TM-A
3.0E-008	1.62	EPS-DGN-FR-DG3	EPS-DGN-FS-DG4
		LCS-MDP-TM-1B	
3.0E-008	1.62	EPS-DGN-FS-DG3	EPS-DGN-FR-DG4
		LCS-MDP-TM-1B	
2.9E-008	1.53	EPS-DGN-FR-DG4	LCS-MDP-TM-1B
		EPS-FAN-FR-DG3EXHG	
2.9E-008	1.53	EPS-DGN-FR-DG3	LCS-MDP-TM-1B
		EPS-FAN-FR-DG4EXHH	
2.4E-008	1.28	EPS-DGN-FR-DG3	EPS-DGN-FR-DG4
		LCS-MDP-FS-1B	
2.2E-008	1.14	EPS-DGN-FS-DG3	DCP-BCH-LP-1B2
2.1E-008	1.10	RSW-MDP-TM-1A	DCP-BAT-LP-1B2

2.1E-008	1.10	DCP-BAT-LP-1B2	EPS-DGN-TM-DG3
2.1E-008	1.09	DCP-BCH-LP-1B2	EPS-FAN-FR-DG3EXHG

Event Tree: LOOP CCDF: 1.6E-006
Sequence: 32-16

CCDF	% Cut Set	Cut Set Events	
1.1E-007	6.42	HCI-MULTIPLE-INJECT	HCI-XHE-XL-INJECT
		HCI-MOV-CC-IVFRO	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FR-DG2
		RCI-TDP-FS-RSTRT	RCI-RESTART
		RCI-XHE-XL-RSTRT	
8.9E-008	5.43	HCI-MULTIPLE-INJECT	HCI-XHE-XL-INJECT
		HCI-MOV-CC-IVFRO	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FR-DG2
		RCI-TDP-TM-TRAIN	
6.9E-008	4.17	EPS-XHE-XL-NR30M	OEP-XHE-XL-NR30M
		EPS-DGN-FR-DG2	RCI-XHE-XO-ERROR
		HCI-XHE-XO-ERROR1	
6.8E-008	4.13	HCI-TDP-TM-TRAIN	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FR-DG2
		RCI-TDP-FS-RSTRT	RCI-RESTART
		RCI-XHE-XL-RSTRT	
6.2E-008	3.80	HCI-MULTIPLE-INJECT	HCI-XHE-XL-INJECT
		HCI-MOV-CC-IVFRO	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FR-DG2
		RCI-TDP-FS-TRAIN	
5.7E-008	3.49	EPS-XHE-XL-NR30M	OEP-XHE-XL-NR30M
		EPS-DGN-FR-DG2	LCS-ASL-HI-031ABCD
4.0E-008	2.44	HCI-TDP-TM-TRAIN	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FR-DG2
		RCI-TDP-FS-TRAIN	
4.0E-008	2.41	HCI-TDP-FS-TRAIN	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FR-DG2
		RCI-TDP-FS-RSTRT	RCI-RESTART
		RCI-XHE-XL-RSTRT	
3.7E-008	2.23	HCI-MULTIPLE-INJECT	HCI-XHE-XL-INJECT
		HCI-MOV-CC-IVFRO	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FR-DG2
		RCI-TDP-FR-TRAIN	
3.3E-008	2.03	HCI-TDP-FS-TRAIN	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FR-DG2
		RCI-TDP-TM-TRAIN	
2.5E-008	1.52	HCI-MULTIPLE-INJECT	HCI-XHE-XL-INJECT
		HCI-MOV-CC-IVFRO	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FS-DG2
		RCI-TDP-FS-RSTRT	RCI-RESTART
		RCI-XHE-XL-RSTRT	
2.4E-008	1.44	HCI-MULTIPLE-INJECT	HCI-XHE-XL-INJECT
		HCI-MOV-CC-IVFRO	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	RCI-TDP-FS-RSTRT

		RCI-RESTART	RCI-XHE-XL-RSTRT
		EPS-FAN-FR-DG2EXHF	
2.4E-008	1.43	HCI-TDP-TM-TRAIN	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FR-DG2
		RCI-TDP-FR-TRAIN	
2.3E-008	1.42	HCI-TDP-FS-TRAIN	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FR-DG2
		RCI-TDP-FS-TRAIN	
2.3E-008	1.41	HCI-TDP-FR-TRAIN	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FR-DG2
		RCI-TDP-FS-RSTRT	RCI-RESTART
		RCI-XHE-XL-RSTRT	
2.1E-008	1.28	HCI-MULTIPLE-INJECT	HCI-XHE-XL-INJECT
		HCI-MOV-CC-IVFRO	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FS-DG2
		RCI-TDP-TM-TRAIN	
2.0E-008	1.23	HCI-MULTIPLE-INJECT	HCI-XHE-XL-INJECT
		HCI-MOV-CC-IVFRO	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	DCP-BAT-LP-1B1
2.0E-008	1.22	HCI-MULTIPLE-INJECT	HCI-XHE-XL-INJECT
		HCI-MOV-CC-IVFRO	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	RCI-TDP-TM-TRAIN
		EPS-FAN-FR-DG2EXHF	
2.0E-008	1.19	HCI-TDP-FR-TRAIN	EPS-XHE-XL-NR30M
		OEP-XHE-XL-NR30M	EPS-DGN-FR-DG2
		RCI-TDP-TM-TRAIN	

Event Tree: LODC1B2 CCDF: 1.3E-006
Sequence: 42

CCDF	% Cut Set	Cut Set Events	
5.6E-007	42.28	HCI-MULTIPLE-INJECT	HCI-XHE-XL-INJECT
		HCI-MOV-CC-IVFRO	DCP-XHE-XA-ALTDC
3.6E-007	27.17	HCI-TDP-TM-TRAIN	DCP-XHE-XA-ALTDC
2.1E-007	15.85	HCI-TDP-FS-TRAIN	DCP-XHE-XA-ALTDC
1.2E-007	9.29	HCI-TDP-FR-TRAIN	DCP-XHE-XA-ALTDC
3.0E-008	2.26	HCI-XHE-XO-ERROR	DCP-XHE-XA-ALTDC
3.0E-008	2.26	HCI-MOV-CC-INJEC	DCP-XHE-XA-ALTDC

BASIC EVENTS (Cut Sets Only)

Event Name	Description	Curr Prob
ACP-BAC-LP-E6	DIVISION E6 AC POWER BUSES FAIL	9.6E-006
ACP-CRB-CC-NORM1C	FAILURE OF BUS 1C NORMAL FEED BREAKER TO OPEN	2.5E-003
ACP-CRB-CC-NORM1D	FAILURE OF BUS 1D NORMAL FEED BREAKER TO OPEN	2.5E-003
ACP-CRB-CC-NORM_E2	FAILURE OF BUS E2 NORMAL FEED BREAKER TO OPEN	2.5E-003
ACP-CRB-OO-ALT1C	FAILURE OF BUS 1C ALTERNATE FEED BREAKER TO C	2.5E-003
ACP-CRB-OO-ALT1D	FAILURE OF BUS 1D ALTERNATE FEED BREAKER TO C	2.5E-003
ACP-TFM-FC-E2E6	FAILURE OF 4160/480 VAC TRANSFORMER BETWEEN B	4.8E-005

Event Name	Description	Curr Prob
ACP-XHE-XA-E5E6	FAILURE TO CROSS-TIE BUSES E5 AND E6	4.0E-002
ADS-TSW-FT-DC125	POWER TRANSFER SWITCH FAILS TO TRANSFER	3.0E-003
DCP-BAT-LP-1B1	DIVISION II 125V DC BATTERY 1B1 FAILS	4.8E-005
DCP-BAT-LP-1B2	DIVISION II 125 VDC BATTERY 1B2 FAILS	4.8E-005
DCP-BCH-LP-1B2	FAILURE OF DIVISION 2 BATTERY CHARGER 1B2	1.2E-004
DCP-BDC-LP-1B2	DIVISION II 125/250 VDC BUS 1B2 IS UNAVAILABL	9.6E-006
DCP-XHE-XA-AC_DC	DEPENDENT FAILURE TO CROSS TIE AC BUSES AND D	1.0E-002
DCP-XHE-XA-ALTDC	FAILURE TO ALIGN ALTERNATE DC SUPPLY	5.0E-002
DUAL-UNIT-LOOP	MULTIPLE UNIT LOOP HAS OCCURRED	5.8E-001
EPS-DGN-FR-DG2	DIESEL GENERATOR 2 FAILS TO RUN	2.1E-002
EPS-DGN-FR-DG3	DIESEL GENERATOR 3 FAILS TO RUN	2.1E-002
EPS-DGN-FR-DG4	DIESEL GENERATOR 4 FAILS TO RUN	2.1E-002
EPS-DGN-FS-DG2	DIESEL GENERATOR 2 FAILS TO START	5.0E-003
EPS-DGN-FS-DG3	DIESEL GENERATOR 3 FAILS TO START	5.0E-003
EPS-DGN-FS-DG4	DIESEL GENERATOR 4 FAILS TO START	5.0E-003
EPS-DGN-TM-DG3	DIESEL GENERATOR 3 UNAVAILABLE DUE TO TEST AN	1.2E-002
EPS-DGN-TM-DG4	DIESEL GENERATOR 4 UNAVAILABLE DUE TO TEST AN	1.2E-002
EPS-DGN-XX-R2H	CONVOLUTION FACTOR FOR ONE EDG-FR * OPR IN 2	2.5E-001
EPS-FAN-FR-DG2EXHF	FAILURE OF DIESEL GENERATOR 2 EXHAUST FAN (F)	4.8E-003
EPS-FAN-FR-DG3EXHG	FAILURE OF DIESEL GENERATOR 3 EXHAUST FAN (G)	4.8E-003
EPS-FAN-FR-DG4EXHH	FAILURE OF DIESEL GENERATOR 4 EXHAUST FAN (H)	4.8E-003
EPS-FAN-FS-DG2EXH	FAILURE OF DG2 EXHAUST FAN (F) TO START	3.0E-003
EPS-PND-CC-DG2AA	FAILURE OF DG2 EXHAUST DAMPER (AA) TO OPEN	1.0E-003
EPS-PND-CC-DG2BD	FAILURE OF DG2 BACKDRAFT DAMPER (F) TO OPEN	1.0E-003
EPS-XHE-XL-NR02H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN	6.5E-001
EPS-XHE-XL-NR30M	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN	8.6E-001
HCI-MOV-CC-INJEC	HPCI INJECTION VALVE CAUSES FAILURE TO START	1.0E-003
HCI-MOV-CC-IVFRO	HPCI INJECTION VALVE FAILS TO REOPEN	1.5E-001
HCI-MULTIPLE-INJECT	MULTIPLE HPCI INJECTIONS REQUIRED	1.5E-001
HCI-TDP-FR-TRAIN	HPCI PUMP TRAIN FAILS TO RUN GIVEN IT STARTED	4.1E-003
HCI-TDP-FS-TRAIN	HPCI PUMP FAILS TO START	7.0E-003
HCI-TDP-TM-TRAIN	HPCI TRAIN IS UNAVAILABLE BECAUSE OF MAINTENA	1.2E-002
HCI-XHE-XL-INJECT	OPERATOR FAILS TO RECOVER HPCI INJECT MOV FAI	8.3E-001
HCI-XHE-XO-ERROR	OPERATOR FAILS TO START/CONTROL HPCI INJECTIO	1.0E-003
HCI-XHE-XO-ERROR1	OPERATOR FAILS TO START/CONTROL HPCI INJECTIO	1.4E-001
LCS-ASL-HI-031ABCD	LEVEL INSTRUMENTS N031-A,B,C,D FAIL HI (PSA)	1.2E-004
LCS-MDP-FS-1B	LCS MDP 1B FAILS TO START	1.5E-003
LCS-MDP-TM-1B	LCS MDP 1B UNAVAILABLE DUE TO TEST AND MAINTE	8.0E-003
NSW-AOV-CC-V129	RHR RM A COOLER ISOLN VLV FAILS TO OPEN	1.2E-003
NSW-AOV-CC-V130	RHR PMP A SEAL COOLER ISOLN VALVE FAILS TO OP	1.2E-003
OEP-XHE-XL-NR02H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 2	3.2E-001
OEP-XHE-XL-NR30M	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 30	7.3E-001
OPR-XHE-XM-DIVXT	OPERATOR FAILS TO CROSS-TIE DIVISION BUSES	4.0E-002
OPR-XHE-XM-DIVXT13	OPERATOR FAILS TO POWER DIVISION E1 FROM DIVI	4.0E-002
RCI-RESTART	RESTART OF RCIC IS REQUIRED	3.0E-001
RCI-TDP-FR-TRAIN	RCIC PUMP FAILS TO RUN GIVEN THAT IT STARTED	4.1E-003
RCI-TDP-FS-RSTRT	RCIC FAILS TO RESTART GIVEN START AND SHORT-T	8.0E-002
RCI-TDP-FS-TRAIN	RCIC PUMP FAILS TO START	7.0E-003
RCI-TDP-TM-TRAIN	RCIC PUMP TRAIN IS UNAVAILABLE BECAUSE OF MAI	1.0E-002
RCI-XHE-XL-RSTRT	OPERATOR FAILS TO RECOVER RCIC FAILURE TO RES	5.0E-001

Event Name	Description	Curr Prob
RCI-XHE-XO-ERROR	OPERATOR FAILS TO START/CONTROL RCIC INJECTIO	1.0E-003
RHR-MDP-FS-1A	RHR MDP 1A FAILS TO START	1.5E-003
RHR-MOV-CC-F007A	RHR LOOP A MINFLOW VALVE F007A FAILS TO OPEN	1.0E-003
RHR-MOV-OO-F048A	RHR HEAT EXCHANGER A BYPASS VALVE F048A FAILS	1.0E-003
RHR-SYS-TM-A	RHR LOOP A UNAVAILABLE DUE TO TEST AND MAINTE	8.0E-003
RHR-XHE-XR-MDP1A	OP FAILS TO RESTORE RHR MDP 1A	1.0E-003
RSW-MDP-FS-1A	RSW MDP 1A FAILS TO START	1.5E-003
RSW-MDP-TM-1A	RSW MDP 1A UNAVAILABLE DUE TO TEST AND MAINTE	1.2E-002
RSW-MOV-CC-F002A	RHR HX1A OUTLET ISOL MOV F002A FAILS TO OPEN	1.0E-003
RSW-MOV-CC-F068A	RHR HX1A FLOW CONTROL MOV F068A FAILS TO OPEN	1.0E-003
RSW-XHE-XR-MDP1A	OP FAILS TO RESTORE RSW MDP 1A	1.0E-003
SPC-MOV-CC-24A	SPC LOOP A INBD INJECTION LINE MOV F024A FAIL	1.0E-003
SPC-MOV-CC-28A	SPC LOOP A OUTBD INJECTION LINE MOV F028A FAI	1.0E-003