June 29, 2001

EA-01-032

Mr. Ted Feigenbaum
Executive Vice President and Chief Nuclear Officer
Seabrook Station
North Atlantic Energy Service Corporation
c/o Mr. James M. Peschel
P.O. Box 300
Seabrook, NH 03874

SUBJECT: FINAL SIGNIFICANCE DETERMINATION FOR A WHITE FINDING AND NOTICE OF VIOLATION AT SEABROOK (NRC INSPECTION REPORT 0500443/2000-011)

Dear Mr. Feigenbaum:

The purpose of this letter is to provide you with the final results of our significance determination of the preliminary White finding identified during the subject inspection conducted between November 7, 2000 and January 18, 2001. This inspection finding, which involved the failure to take adequate corrective actions to address degraded components associated with one of the two emergency diesel generators (EDG), was assessed using the significance determination process. The finding was preliminarily characterized as White, an issue of low to moderate safety significance, as noted in the NRC letter dated March 2, 2001, which transmitted the related inspection report.

The finding was identified after a failure of the 1B diesel generator occurred during a 24-hour surveillance test in November 2000. The failure involved the crankcase overpressurizing, resulting in lifting of the crankcase relief cover assemblies, as well as displacement of the crankcase exhauster hose. Subsequent inspection revealed damage to one of the pistons and its cylinder liner as a result of non-uniform thermal growth of the aluminum piston skirt. That growth caused scuffing, scoring, and transfer of aluminum material from the piston skirt to the cylinder liner. The heat generated by the friction (galling) between the skirt and the liner bore, coupled with the hot combustion gas blow-by, eventually ignited oil vapor in the crankcase.

Approximately 5 years earlier, on November 21, 1995, you had replaced the liner for one of the cylinders of the 1B diesel generator due to an out-of-round wear condition. In addition, on April 17, 1999, you replaced a liner for another cylinder in that same diesel generator due to an observed polished finish appearance and lack of crosshatch pattern, which was indicative of heavy wear. However, no condition report was written in either case. As a result of not entering those degraded conditions into the corrective action process, you did not fully evaluate the cause of those degraded conditions to prevent any subsequent recurrence of degraded cylinder liner conditions. This performance issue (failure to place these degraded conditions into the corrective action process and evaluate the cause of the degraded conditions of the emergency diesel generator) was determined to be a potential cause in the 1B diesel generator failure in November 2000.

This performance issue, which also constitutes a violation of 10 CFR Part 50, Appendix B, Criterion XVI, had several other aspects. For example, you also: (1) failed to establish appropriate quantitative or qualitative acceptance criteria for boroscopic inspections of the diesel generator cylinder liners; (2) did not incorporate industry operating experience to modify your diesel generator tests to minimize wear; and (3) did not evaluate the worn cylinder liners replaced during previous outages to determine the cause of the wear.

This issue was assessed using a Phase 3 Significance Determination Process analysis and was preliminarily determined to be White (i.e., an issue with some increased importance to safety, which would require additional NRC inspection). The issue has low to moderate safety significance because emergency diesel generators are an important mitigating system during a loss of offsite power event. Our March 2, 2001, letter also provided you an opportunity to attend a Regulatory Conference or submit a written response to address the finding. You declined a conference and rather, discussed your position in your letter dated April 6, 2001. In your letter, you did not deny that a violation occurred. However, you did contend that this finding was of very low risk significance and should be classified as a Green finding, and that you had taken prompt aggressive corrective action to address the diesel generator failures.

The NRC has evaluated the information developed during the inspection as well as the information you presented in your April 6, 2001, response. The NRC acknowledges that you took corrective action following the 1B diesel generator failure. Your actions included partial disassembly of both diesel generators, replacement of the lubricating oil, and reassembly to the manufacturer's specifications and tolerances regarding cylinder liner finish and piston cleanliness. The reassembly of the 1B diesel generator included replacement of the No. 7 cylinder piston skirt and liner, all main bearings, and the crankshaft. More broadly, the NRC recognizes that you have initiated steps to address the underlying problems that contributed to the diesel failure. These steps include a program to address long term reliability of safety related systems. The NRC will assess the effectiveness of these corrective actions in future inspections.

Based on our evaluation as documented in the enclosed Review of Licensee Response, the NRC has made a final significance determination that the finding should be classified as White, an issue of low to moderate significance. You have 10 business days from the date of this letter to appeal the staff's determination of significance for the identified finding. Such appeals will be considered to have merit only if they meet the criteria given in NRC Inspection Manual Chapter 0609, Attachment 2.

The subject violation is cited in the enclosed Notice of Violation (Notice). The circumstances surrounding the violation were also described in detail in the subject inspection report. In accordance with the NRC Enforcement Policy, NUREG-1600, the Notice of Violation is considered escalated enforcement action because it is associated with a White finding. You are required to respond to this letter and should follow the instructions specified in the enclosed Notice when preparing your response. Your response should include details of your program to address long term reliability of safety related systems, as well as steps to assure that identification of conditions adverse to quality, such as the DG-1B problems in 1995 and 1999, are promptly and thoroughly evaluated for cause and are effectively corrected. The NRC will use your response, in part, to determine whether further enforcement action is necessary to ensure compliance with regulatory requirements.

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/

Hubert J. Miller
Regional Administrator

Docket No: 05000443
License No: NPF-86

Enclosures:
1. Notice of Violation
2. Review of Licensee Response
3. Point-By-Point Discussion of Risk Factors

cc w/encls:
B. D. Kenyon, President and Chief Executive Officer
J. M. Peschel, Manager - Regulatory Programs
G. St. Pierre, Station Director - Seabrook Station
D. Roy, Training Manager - Seabrook Station
D. E. Carriere, Director, Production Services
W. J. Quinlan, Esquire, Assistant General Counsel
W. Fogg, Director, New Hampshire Office of Emergency Management
D. McElhinney, RAC Chairman, FEMA RI, Boston, Mass
R. Backus, Esquire, Backus, Meyer and Solomon, New Hampshire
D. Brown-Couture, Director, Nuclear Safety, Massachusetts Emergency Management Agency
F. W. Getman, Jr., Vice President and Chief Executive Office, BayCorp Holdings, LTD
R. Hallisey, Director, Dept. of Public Health, Commonwealth of Massachusetts
M. Metcalf, Seacoast Anti-Pollution League
D. Tefft, Administrator, Bureau of Radiological Health, State of New Hampshire
S. Comley, Executive Director, We the People of the United States
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DATE	05/04/01	05/07/01	05/21/01	05/11/01	05/12/01

OFFICE	OE	NRR	RI/ORA	HQ/NRR	
NAME	FCongel **	DCoe (RJU for) *	HMiller (HJM)	MJohnson **	
DATE	06/26/01	05/15/01	06/29/01	06/26/01	

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*** Per phone call with P. Koltay**
**** Received HQ concurrence via e-mail on 6/26/01 from Dixon-Herrity**

Enclosure 1

Notice of Violation

North Atlantic Energy Service Corporation
Seabrook Station

Docket No. 50-443
License Nos. NPF-86
EA-01-032

During an NRC inspection conducted from November 7, 2000 to January 18, 2001, a violation of NRC requirements was identified. In accordance with the "General Statement of Policy and Procedure for NRC Enforcement Actions," NUREG-1600, the violation is listed below:

> 10 CFR 50, Appendix B, Criterion XVI, “Corrective Action,” requires, in part, that measures shall be established to assure that conditions adverse to quality 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 prevent repetition.
>
> Seabrook Station Technical Specification 6.7.1.a states, in part, that written procedures shall be implemented. Seabrook Station Administrative Procedure OE 3.1, “Initiating a Condition Report,” Rev. 13, requires initiation of a condition report when an unwanted or unexpected condition occurs.
>
> Contrary to the above, when significant conditions adverse to quality were identified on November 21, 1995 and April 17, 1999, involving degraded components in emergency diesel generator DG-1B, the licensee failed to determine the cause of the condition and failed to take appropriate corrective actions to prevent recurrence. Specifically, during the 18 month inspections of DG-1B performed on those dates, cylinder liners revealed heavy wear, as evidenced by an out-of-round wear condition on one liner and a polished appearance and lack of honing (crosshatch pattern) on the inside bore surface of the other liner. Although the No. 10 degraded cylinder liner was replaced on November 21, 1995, and the No. 11 cylinder liner was replaced on April 17, 1999, using work requests, condition reports were not written. As a result, the licensee failed to determine the cause of the degraded cylinder liners consistent with the diesel generator’s importance to safety. Therefore, similar degradation went unnoticed until an actual failure occurred to cylinder No. 7, resulting in the failure of DG-1B on November 1, 2000.
>
> This violation is associated with a WHITE Significance Determination Process finding.

Pursuant to the provisions of 10 CFR 2.201, North Atlantic Energy Service Corporation is hereby required to submit a written statement or explanation to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555 with a copy to the Regional Administrator, Region I, and a copy to the NRC Resident Inspector at the facility that is the subject of this Notice, within 30 days of the date of the letter transmitting this Notice of Violation (Notice). This reply should be clearly marked as a "Reply to a Notice of Violation" and should include for the violation: (1) the reason for the violation, or, if contested, the basis for disputing the violation or its significance, (2) the corrective steps that have been taken and the results achieved, (3) the corrective steps that will be taken to avoid further violations, and (4) the date when full compliance will be achieved. Your response may reference or include previous docketed correspondence, if the correspondence adequately addresses the required response. If an adequate reply is not received within the time specified in this Notice, an order or a Demand for Information may be issued as to why the license should not be modified, suspended, or revoked, or why such other action as may be proper should not be taken. Where good cause is shown, consideration will be given to extending the response time.

If you contest this enforcement action, you should also provide a copy of your response, with the basis for your denial, to the Director, Office of Enforcement, United States Nuclear Regulatory Commission, Washington, DC 20555-0001.

Because your response will be made 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), to the extent possible, it should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the public without redaction. ADAMS is accessible from the NRC Web site at http://www.nrc.gov/NRC/ADAMS/index.html (the Public Electronic Reading Room). If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request withholding of such material, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim of withholding (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.790(b) to support a request for withholding confidential commercial or financial information). If safeguards information is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21.

In accordance with 10 CFR 19.11, you may be required to post this Notice within two working days.

Dated this 29th day of June 2001

Enclosure 2

REVIEW OF LICENSEE RESPONSE

Background

The NRC's Reactor Oversight Program (ROP) Significance Determination Process (SDP) requires that inspection findings be categorized in accordance with their relative safety significance. The NRC's significance determination for the Emergency Diesel Generator (EDG) DG-1B failure was documented in NRC Inspection Report 05000443/2000-11. Using the SDP, the NRC determined the risk significance of the degraded EDG was low to moderate (White). North Atlantic Energy Service Corporation (NAESCo) provided a response to this inspection report in a letter to the NRC dated April 6, 2001. In this letter, NAESCo stated that it disagreed with the NRC's risk determination and that the finding regarding the EDG failure should be categorized as having very low risk significance (Green). Enclosure 1 to NAESCo's letter provided "North Atlantic's Alternate Perspectives to Issues Described in NRC Inspection Report 2000-11." This review was performed to determine if information in the licensee's response letter provided an adequate basis for changing the NRC's risk determination. After carefully considering the licensee's response, the NRC maintains that the finding is appropriately classified as White.

Discussion

On October 21, 2000, the plant entered a refueling outage following plant operating cycle 7. During that refueling outage, DG-1B failed on November 1, 2000, when the crankcase overpressurized, lifting the crankcase relief cover assemblies as well as displacing the crankcase exhauster hose. Prior to that failure, DG-1B had last passed a surveillance test on October 18, 2000 (a four hour test). The challenge of this risk assessment was to apply SDP techniques to establish a reasonable estimate of risk associated with the degraded condition of DG-1B.

Uncertainty is inherent in risk assessments. The NRC based its risk assessment on what was believed to be the most realistic evaluation of available data. The NRC was very conscious during its risk assessment to avoid giving *undue* weight to the factors that could have potentially either increased or decreased the significance of conditions surrounding the DG-1B failure. The key factor that was critical in this risk assessment was the fault exposure time of DG-1B (i.e., the amount of time that DG-1B would have been unavailable to meet its mission time of 24 hours). The NRC used the accumulated loaded run time of DG-1B to determine its fault exposure time.

After DG-1B passed its four hour surveillance test on October 18, it was not run again until after the plant entered a refueling outage on October 21. From October 24 to October 29, DG-1B was started and run 9 times before it was manually shut down due to high lubricating oil differential pressure across the oil strainer. The operators secured DG-1B prior to receiving the automatic trip. DG-1B damage became evident when metal particles were noted in an oil sample.

To estimate the fault exposure time for DG-1B, the NRC used accumulated loaded run time by calculating when DG-1B would have automatically tripped due to high lubricating oil differential pressure. After establishing that point in time when DG-1B would have automatically tripped, the NRC determined the start time of the previous 24 hours of accumulated loaded run time to be near the end of the last four hour surveillance test on October 18. As a result, the NRC chose the fault exposure time as the number of days from that date (October 18), while the plant was operating, until the plant entered its refueling outage on October 21 (3 days). By using risk insights from the plant specific probabilistic risk assessment with a fault exposure time of 3 days, the NRC calculated a change in core damage frequency of slightly greater than 1E-6. The ROP threshold for a White finding is 1E-6; therefore, the NRC concluded that this finding was White.

In performing its risk assessment, the NRC also considered using a “T/2 calculation” to determine the fault exposure time (where T represents the time back to the last successful 24 hour surveillance test which had occurred approximately 18 months prior to the DG-1B failure). By going back to the last successful 24-hour endurance run, the fault exposure time would have been approximately nine months, which in this case would have significantly increased the risk estimate. However, the NRC concluded that using this “T/2 calculation” to determine the fault exposure time would not correctly estimate risk. DG-1B was run monthly, several hours at a time, since the last refueling outage approximately 18 months prior to its failure. The NRC judged that using the “T/2 calculation” would have less accurately reflected the remaining capability of DG-1B.

NAESCo’s position, as described in its April 6, 2001 response, is that it was the number of thermal transient conditions (i.e., EDG starts), not EDG accumulated run time, that determined the life of DG-1B. Therefore, NAESCo believes that it was the thermal transient conditions encountered during nine DG-1B starts, after the plant shutdown, that initiated the failure of DG-1B. Prior to the October 29 start, NAESCo believes that if DG-1B had started, it would have run for its entire mission time. In part, NAESCo believes that the nine DG-1B starts between the beginning of the outage and October 29 demonstrated the remaining capability of the DG-1B. Based on this position, NAESCo contends that DG-1B was operable throughout plant operating cycle 7, and the NRC did not consider engine starts in calculating the fault exposure time, and therefore, did not account for the wear that results from these starts.

The NRC acknowledges that engine starts cause wear on diesel generator parts such as cylinder liners, which were damaged in this case. However, wear during normal operations can also be important. This is particularly true in cases where an engine is in a degraded state (as was the case here). An engine in a degraded state (i.e., critical tolerances are degraded, clearances between moving parts are reduced, excessive wear products are in the lubricating oil, carbon deposits are on pistons, etc.) can result in accelerating wear and degradation during operation. The fact that DG-1B ran for a time on October 29 before the strainer clogging became evident supports this view. Therefore, the NRC believes that there is sufficient basis to use operating time to estimate the remaining life. Further, DG-1B was simply never run for a significant period following any of the post-October 18 operations to demonstrate whether it was able to meet full duty requirements (i.e., run for 24 hours) in its degraded condition. NAESCo has provided no specific information or data that would reliably support the view that degradation was so dominated by start cycles that the effect of run time of the EDG in a degraded condition (such as DG-1B) is not important. Therefore, the NRC concludes that NAESCo has not provided an adequate basis for the NRC to change its SDP White characterization of this finding.

Summary

The NRC has made a final significance determination that the finding should be classified as low to moderate (White). A review of the licensee's April 6, 2001, response did not identify any new technical information that was not considered when the NRC made the original safety significance determination for this finding. NRC Inspection Report 05000443/2000-11 documented several factors that influenced our assessment. In its letter dated April 6, 2001, NAESCo responded to the inspection report findings by addressing each of these factors. Enclosure 3 contains a point-by-point discussion of these factors for further clarification.

Enclosure 3

POINT-BY-POINT DISCUSSION OF RISK FACTORS

1. DG-1B Out-of-Service During Shutdown

Special Inspection Team Position:

The risk determination does not quantify or consider the risk associated with having the EDG out-of-service while the plant was in a shutdown (below Mode 2) condition.

NAESCo Position:

This statement is incorrect. Engineering Evaluation (EE)-01003 describes the significance determination for the November 1, 2000, DG-1B failure (refer to NAESCo letter dated April 6, 2001, Attachment B). This evaluation explicitly addresses the risk associated with the failure of DG-1B during the outage and concluded that the event risk was insignificant in that it was equivalent to a significance determination of Green.

In conclusion, this component of uncertainty is not applicable.

Response to NAESCo's Comments:

The NRC staff agrees that EE-01003 did assess the risk significance of the EDG failure during the outage. This statement in the inspection report was referring to the NRC's risk assessment which did not include a change in core damage frequency estimate for the outage period. The factors listed in the inspection report were additional considerations the NRC used in making a determination regarding the significance of this finding. The factors are not listed in order of importance. The NRC staff agrees with the information in the licensee's engineering evaluation that the risk contribution from the EDG failure during the shutdown period was small.

2. Failure was Random and Independent

Special Inspection Team Position:

The licensee's event evaluation team determined that the failure mechanism was random and independent. The risk assessment did not include a random EDG failure during the past operating cycle.

NAESCo Position:

The NAESCo PRA model is designed to calculate the risk impacts due to random failure of the modeled components. Random EDG failures are modeled in terms of both demand failures (i.e., start failures) and operating failures (i.e., run failures). NAESCo used the November 1, 2000, failure to update the EDG failure frequencies in the PRA model.

The discussion on random failure in the event evaluation report means that without detailed knowledge of the physical condition of the engine, it is not easy to predict, in advance, the failure in any one piston or cylinder. However, this does not mean that once the failure has occurred that it is not possible to accurately determine the circumstances around the failure and determine how long the engine would have been capable of operating in a design basis event.

In conclusion, the ability to use the failure information to determine how long the engine would have been capable of operating eliminates this component of uncertainty.

Response to NAESCo's Comments:

The NRC agrees with NAESCo that once the failure occurred, it is possible to more accurately determine the circumstances of the failure and better predict how long the engine would have run to supply needed power. The NRC described its view of remaining engine operating time in Enclosure 2 and in response to item No. 4.

3. Potential for a Common-Mode Failure

Special Inspection Team Position:

The potential for a common-mode failure of DG-1A was not reflected in the assessment. The licensee's event evaluation team identified several causal factors (i.e., method of testing and maintaining the EDGs in a standby condition) that were common to both EDGs.

NAESCo Position:

NAESCo also believes that it is important to consider the potential common mode effects. As a result, common cause potential was evaluated and described in EE-01003. As described in EE-010001, the EDG failure mechanism was a combination of a latent condition (i.e., component wear as a result of testing, etc.) and a transient condition (e.g., fast starts). Without either sufficient wear as an initial condition, or the thermal transient that triggers the latent condition, no failure is likely to occur. Inspection of DG-1A revealed less wear than that observed with DG-1B. This is most likely due to the fewer start cycles and run time experienced by DG-1A versus DG-1B. The reduced wear on DG-1A renders it unlikely that a common mode failure would occur during the window of the DG-1B failure. In conclusion, this component of uncertainty has minimal influence given the empirical examination evidence of DG-1A.

Response to NAESCo's Comments:

The potential common cause failure mechanisms associated with this finding are important in making an assessment of this issue. The root causes of fast starts and loading of the EDGs were common to both engines. While degradation in the DG-1A engine was not as substantial as that experienced in the DG-1B engine, signs of similar degradation (i.e. polished cylinder liner surface) were present in the DG-1A engine and repairs were required. Any root cause that affects both trains of safety-related equipment is more significant than a condition that is isolated to a single train of equipment. The NRC acknowledges that DG-1A had less starts and did not exhibit the same degree of degradation seen in DG-1B. As required by the SDP in Inspection Manual Chapter 0609, the NRC listed this item as an assumption made, but not quantified. As stated before, the NRC used operating time and not common mode failure probability to estimate fault exposure time and thus risk.

4. Insufficient Surveillance and Lubricating Oil Test Data

Special Inspection Team Position:

NAESCo's surveillance and lubricating oil test data were insufficient to demonstrate that the EDG would have functioned for the required PRA 24-hour mission time during the last operating cycle. The monthly surveillance test runs were typically about 3 to 4 hours in length, which is far less than the 24-hour mission time. In fact, the EDG operating parameters were essentially normal during the initial portion of the October 29, 2000, 24-hour run. However, the operators were required to secure the EDG later in the test due to elevated lubricating oil strainer differential readings.

NAESCo Position:

Implicit with this component of uncertainty, NAESCo stated that the Special Inspection Team appears to be making the argument that the EDG failure would only have manifested itself during the longer (i.e., 24-hour) runs and not the shorter monthly surveillance runs. However, the Special Inspection Team has not provided a factual basis for this belief. As described in EE-010001 and above, the failure was the result of the combination of the latent condition of the EDG and a thermal transient. The shorter monthly surveillances experienced essentially the same thermal transients experienced during the 24-hour runs in that they both involve fast starts and rapid loading of the EDGs. It is recognized that the 24-hour Technical Specification (TS) runs are somewhat more stressful on the diesel generators than the monthly surveillances since the engines are loaded to 110% in the first two hours of operation. However, this loading, as the loading experienced during the monthly surveillances, is significantly greater than the loads that would be experienced during a design basis event. Notwithstanding, for both the monthly and 24-hour TS surveillances, after the EDGs have reached equilibrium temperature, the thermal transient is over and the engine operates in a steady state equilibrium condition. As a result, there is far less potential for differential thermal growth of the piston skirt or engine components, and therefore, no apparent failure initiation mechanism.

Inspection Report 2000-11 notes that the DG-1B operating parameters were essentially normal during the initial portion of the October 29, 2000, 24-hour run. This normal operation was due to the fact that the failure was first initiated on that date as evidenced by the first occasion in the operating cycle of an increase in lubricating oil strainer differential pressure beyond the normal band of 2 to 4 psid (refer to EE-010001). In other words, the engine start on October 29 was the thermal transient that initiated the failure process. Lubricating oil strainer differential pressure started increasing as this run progressed as material from the failing piston and cylinder began being deposited on the strainer.

As noted in EE-010001, the DG-1B TS surveillance tests conducted during the operating cycle and the lubricating oil samples analyzed during the operating cycle verified that the engine was functioning normally. These surveillance tests provide assurance that the engine was operable.

In conclusion, this component of uncertainty is not applicable.

Response to NAESCo's Comments:

Oil samples were taken on DG-1B in July 2000 and not again until following the October 29 test where significant particulate was identified in the oil sample. The intent of listing this as a factor was simply to state that oil analysis information corroborating the EDG condition for the period from July to October was not available. Therefore, the NRC staff was unable to confirm, by the oil sample data, that the DG-1B pistons and cylinder liners were not wearing during this period. However, the NRC agrees that oil strainer differential pressure measurements during monthly surveillance tests did not indicate an abnormal trend during this period.

NAESCo's response also discusses differences in positions taken regarding the impact of run time versus engine starts. NAESCo indicated that the Special Inspection Team appeared to be making the argument that the EDG failure would only have manifested itself during the longer (i.e., 24-hour) runs and not the shorter monthly surveillance runs. This is the key difference in the quantitative risk assessments done by NAESCo and the NRC. The NAESCo risk assessment assumes that an engine start impact on the EDG is roughly equivalent to approximately 8 hours of loaded run time or more. This assumption and the actual engine starts and run time during the outage resulted in NAESCo concluding that the EDG would have operated for at least 96 hours during the last operating cycle. The NRC's quantitative risk assessment best estimate was that the EDG would not have operated for its mission time (24 hours) for approximately 3 days during the past operating cycle.

The NRC acknowledges that engine starts cause wear on EDG parts such as cylinder liners, which were damaged in this case. However, wear during normal operations can also be important. This is particularly true in cases where an engine is in a degraded state (as was the case here). An engine in a degraded state (i.e., critical tolerances are degraded, clearances between moving parts are reduced, excessive wear products are in the lubricating oil, carbon deposits are on pistons, etc.) can result in accelerating wear and degradation during operation. The fact that DG-1B ran for a time on October 29 before the strainer clogging became evident supports this view. Therefore, the NRC believes that there is sufficient basis to use operating time to estimate the remaining life. Further, DG-1B was simply never run for a significant period following any of the post-October 18 operations to demonstrate that it was able to meet full duty requirements in its degraded condition. NAESCo has provided no specific information or data that would reliably support the view that degradation was so dominated by start cycles that the effect of run time of the EDG in a degraded condition (such as DG-1B) is not important.

5. Lubricating Oil Samples

Special Inspection Team Position:

Lubricating oil analysis samples taken after the October 29, 2000, run indicated a significant wear particle concentration. The previous lube oil results were obtained on July 26, 2000, for the DG-1B, which was prior to the postulated EDG failure.

NAESCo Position:

As described in EE-01001 and above, the DG-1B lubricating oil strainer differential pressure remained in the normal band (approximately 2 to 4 psid) during the entire operating cycle and through the start of the refueling outage (which began on October 21, 2000), up to the 24-hour run on October 29, 2000. This provides evidence that the failure had not been initiated until after the October 29, 2000, run. In conclusion, this component of uncertainty is not applicable.

Response to NAESCo's Comments:

As stated above, the NRC staff agrees that the operating cycle surveillance test oil strainer differential pressure measurements did not indicate substantial piston or liner degradation. The factor considered was that the oil sample analysis does not provide information during the time of interest at the end of Cycle 7. In addition, evaluating the wear and contamination of the lubricating oil was also determined to be inadequate by NAESCo in its event evaluation for CR 00-11909 and CR 00-12126, "Diesel Generator Lube Oil Strainer High Differential Pressure." Therefore, the NRC staff could not use oil sample results alone to confirm the EDG was available throughout the cycle.

6. Estimation of Run Time on October 29, 2000

Special Inspection Team Position:

NAESCo calculated that DG-1B would have operated for approximately 16 hours during the October 29, 2000, surveillance while the NRC inspectors calculated that DG-1B would have operated for 15.5 hours during this surveillance test. This minor difference affected the postulated failure date for DG-1B. The difference was attributed to NAESCo's calculation, which used an assumed value for the initial strainer differential pressure, whereas the NRC inspector's calculation relied solely on data recorded during the 24-hour surveillance test. NAESCo's approach introduced a non-conservative bias into their final EDG run time determination.

NAESCo Position:

Notwithstanding the differences in the calculations described above, the magnitude of the difference between NAESCo's and the Special Inspection Team's run time estimate is insignificant at best. In fact, both calculations validate one another and demonstrate that this component of uncertainly is of minimal significance.

Response to NAESCo's Comments:

The NRC staff agrees that the difference in estimated operating time is not a significant element of uncertainty with respect to the change in core damage frequency estimates. The NRC also believes it may have overestimated the operating time since strainer differential pressure increases could reduce oil flow, thus further increasing wear rates. However, accounting for this change in wear rates would not, in the NRC's judgement, change the White characterization. As stated in the NRC summary in Enclosure 2, NAESCo has not provided a sufficient basis to not use loaded run time to estimate fault exposure time.

7. DG-1B Recovery

Special Inspection Team Position:

The final EDG failure event was determined to be unrecoverable, whereas NAESCo's Plant Risk Assessment (PRA) model assumed that EDG failures are recoverable within a specified period of time.

NAESCo Position:

While the Special Inspection Team is incorrect regarding NAESCo's PRA model assuming all EDG failures are recoverable (refer to EE-01003), it is correct that the final DG-1B failure was non-recoverable. However, the Special Inspection Team's risk evaluation is not based on the final failure of the engine, which occurred on November 1, 2000, but rather on the October 29, 2000, run when the engine first started to fail and the strainers exhibited increased differential pressure. The October 29, 2000, run which was terminated due to increasing lubricating oil strainer differential pressure was recoverable. Recovery was accomplished by changing the strainers. DG-1B was run after the October 29 shutdown four times for a total loaded run time of 24 hours 23 minutes before the crankcase over pressurization event on November 1, 2000. Hence, the engine demonstrated that it would have run for more than its mission time following recovery after the onset of the failure on October 29, 2000.

It is recognized that after the strainers were replaced following the October 29, 2000 run, the strainers and lubricating oil were again replaced on October 30, 2000. However, the latter strainer and oil replacement is inconsequential to the ability to run for 24-hours following recovery. Specifically, the engine ran loaded for a total of 19 hours 34 minutes after October 29, 2000, before the strainer differential pressure reached 7 psid on October 30, 2000, when the engine was shutdown to replace the strainers. The observed strainer loading rate was significantly less than that seen during the October 29, 2000, run. Even if one conservatively assumes the Special Inspection Team's calculated strainer loading rate from the October 29, 2000 run, it is unlikely that the low lubricating oil pressure trip setpoint would have been reached prior to exceeding the 24-hour mission time. Hence, DG-1B demonstrated that it would have run in excess of the 24-hour mission time following recovery from the shutdown on October 29, 2000. In conclusion, this component of uncertainty is not applicable.

Response to NAESCo's Comments:

Typical PRA models credit recovery of one or more EDGs. The NRC should not have made reference specifically to the NAESCo PRA model without verification of credit for recovery. When the inspection report referred to "the final EDG failure," the NRC was referring to the failure that occurred on November 1, 2000.

The strainer design is such that it would have required considerable time to remove the strainer filters and clean and/or replace them. Furthermore, as demonstrated by the event that occurred on November 1, even if DG-1B was recovered, it could not be relied upon to complete a 24-hour run. The NRC's consideration was that easily recoverable failures are less risk significant. In the case of the failure mechanisms present in DG-1B, the NRC did not believe that a failure would be easily recoverable and therefore the risk was increased. This factored into the NRC's considerations when making its assessment of this issue.

8. Correction for Engine Start Cycles

Special Inspection Team Position:

The risk assessment did not correct the assumed EDG failure date for the number of start cycles placed on the unit after the unit entered Mode 2. The EDG wear would also be expected to be a function of the number of start cycles experienced. The EDG was started nine times between the start of the refueling outage (OR07) that started on October 21, 2000, and the EDG run on October 29, 2000.

NAESCo Position:

The Special Inspection Team did not attempt to quantify or rank the significance of this uncertainty. Engineering Evaluation 010001 quantified the impact of engine starts on wear by using data from both the engine designer and the former chief engineer for Coltec. Specifically, engine wear associated with each start was determined to be equivalent to that of approximately 8 to 10 hours of full load operation. The engineering evaluation concluded that the nine starts during the outage prior to the shutdown on October 29, 2000, were equivalent to 72 hours of loaded run time. Adding this to the actual/estimated run time provides for a total loaded run time of over 96 hours.

The above determination is consistent with the guidance provided by the NRC Staff in NUREG-1366, “Improvements to Technical Specification Surveillance Requirements.” Specifically, NUREG-1366 indicates that fast starts and rapid loading can cause rapid piston and cylinder liner wear.

In conclusion, fast starts of EDGs are a significant component of uncertainty that warrants being quantified.

Response to NAESCo’s Comments:

The NRC staff agrees that EDG wear is exacerbated by engine starts. Nine starts during the outage up to October 29, monthly surveillance tests, oil samples and significant run time during the outage all demonstrated the reliability of DG-1B to start. However, as previously explained in Section 4 of this enclosure, NAESCo has provided no specific information or data that would reliably support the view that degradation was so dominated by start cycles that the effects of run time of the EDG in a degraded condition (such as DG-1B) is not important.

9. Successful Runs following October 29, 2000

Special Inspection Team Position:

The EDG was run successfully after the October 29, 2000, shutdown three times (of loaded durations between 1 and 13) for a total of 19 hours and 44 minutes before the test run on November 1, 2000, which culminated in the over-pressurization event. The diesel engine lubricating oil was changed and the strainer was cleaned once and replaced once between these runs. This illustrates that the EDG had some load capability while the cylinder/piston degradation progressed.

NAESCo Position:

As clarification to the above, the engine actually ran loaded for a total of 20 hours 52 minutes during this time frame. Additionally, if one does not exclude the last run on November 1, 2000, the engine ran for a total of 24 hours 23 minutes from the October 29, 2000, shutdown. The Special Inspection Team recognized that this illustrates that the EDG had some load capability while the cylinder/piston degradation was in progress. However, the aforementioned load carrying capability should not be minimized since more than 23 hours of the total loaded run time was with loads at or above the values stated in the TS, which exceed the loads expected during actual accident conditions.

In conclusion, the fact that the engine was capable of running at load in excess of 24 hours following the October 29, 2000, shutdown is significant in that the engine was sufficiently robust to continue to perform as designed.

Conclusion on Uncertainties

As demonstrated above, of the seven components of uncertainty that were described in Inspection Report 2000-11 as non-conservative, after analysis, two have negligible affect and five were not applicable regarding their affect on DG-1B run time and therefore risk. Of the conservative uncertainties, the successful runs following the engine shutdown on October 29, 2000, demonstrate that the DG-1B was recoverable. The other conservative uncertainty regarding fast starts of emergency diesel generators is a significant component of uncertainty that warrants consideration. When quantified, this component of uncertainty demonstrates that the DG-1B would have been capable of operating at load for at least 96 hours after the plant had been shutdown for the refueling outage. This is significantly in excess of the engine's 24-hour mission time. This component of uncertainty dominates the other uncertainties described in the inspection report. Given that the Special Inspection Team found that the engine would have been capable of operating at load for 23 hours and 51 minutes, the lack of impact of the non-conservative uncertainties, and the significance of the affect engine starts have on the calculated run time, North Atlantic believes that the DG-1B was capable of operation for greater than 24 hours.

Risk Associated with this Event

NAESCo determined the risk from this event utilizing the NRC's Significance Determination Process. NAESCo's evaluation, as provided in Attachment B, shows this event to be of low significance and a classification of Green.

Inspection Report 2000-11 also provided an assessment of the risk associated with the DG-1B failure. The Special Inspection Team determined that the engine would have been capable of operating at load for 23 hours and 51 minutes after the plant had been shutdown for the outage. The difference between this run time and the 24-hour mission was 9 minutes. Fault exposure time was determined to be the number of days from the last monthly DG-1B surveillance where the engine ran at load for at least 9 minutes and the date that the plant shutdown for the refueling outage. Since the last monthly DG-1B surveillance occurred three days prior to the refueling outage, the Special Inspection Team assumed three days of fault exposure time.

According to the new oversight program, the method of determining fault exposure time when there is uncertainty involved is to use one-half the time from the last successful surveillance run (T/2 approach). However, the Special Inspection Team did not consider using the T/2 method from the last successful monthly surveillance that was conducted three days prior to the refueling outage. No basis is provided for why this option was not explored.

NAESCo believes that if a fault exposure time is to be assumed, it is appropriate to utilize the T/2 method using the last monthly surveillance. As described in the uncertainty analysis above, the root cause of the engine failure is the non-uniform thermal growth of the piston. The Special Inspection Team agreed with the cause in Inspection Report 2000-11. The non-uniform thermal growth is caused by the thermal transient that is established during the initial engine start and load sequence. The shorter monthly surveillances experience essentially the same thermal transients experienced during the 24-hour runs in that they both involve fast starts and rapid loading of the DGs. As a result, the failure experienced by DG-1B would be manifested by either monthly or 24-hour surveillances.

Conclusions on Risk

This event is of low risk significance and is a classification of Green.

Response to NAESCo's Comments:

The NRC staff agrees that the 21 hours of run time following the October 29 test demonstrated the capability for the EDG to run in a degraded state for several hours. However, during this period it is clear that significant damage had likely occurred to the piston and cylinder liner and prolonged EDG operation was in doubt. The NRC staff recognizes that the EDG functioned, which was included in the NRC quantitative risk analysis. The NRC staff included 8 hours projected time before high strainer differential pressure would trip the EDG in the quantitative analysis, because of the substantial run time that occurred after the October 29 strainer clogging.

The NRC also evaluated consideration of a "T/2 calculation" to determine the fault exposure time (where T represents the time back to the last successful 24 hour surveillance test which had occurred approximately 18 months prior to the DG-1B failure). By going back to the last successful 24-hour endurance run, the fault exposure time would have been approximately nine months, which in this case would have significantly increased the risk estimate. However, the NRC concluded that using this "T/2 calculation" to determine the fault exposure time would not correctly estimate risk. DG-1B was run monthly, several hours at a time, since the last refueling outage approximately 18 months prior to its failure. The NRC judged that using the "T/2 calculation" would have not reflected the remaining capability of DG-1B. The NRC has made a final significance determination that the finding should be classified as low to moderate (White).