December 23, 2003

MEMORANDUM TO: Ledyard B. Marsh, Director
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

FROM: Scott F. Newberry, Director */RA/*
Division of Risk Analysis and Applications
Office of Nuclear Regulatory Research

SUBJECT: TRANSMITTAL OF FINAL ASP ANALYSIS OF AUGUST 2001 OPERATIONAL CONDITION AT D.C. COOK 1 & 2

This memorandum provides the results of the final Accident Sequence Precursor (ASP) Program analysis of operational conditions which were discovered at D.C. Cook, Units 1and 2. These conditions were documented in NRC Inspection Reports 50-315/316/01-17, dated March 21, 2002. We prepared the final analysis based on our review and evaluation of comments from the licensee and NRC staff on the preliminary analysis of this event. The analysis was clarified as a result of comments. There were also minor changes to the quantitative result, however, the conclusions remain unchanged. Attachment B to the enclosed analysis contains our responses to specific comments.

Transmittal to licensee requested. We are requesting NRR/DLPM to send this final ASP analysis to the licensee for information along with our responses to the licensee's and other peer review comments. The analysis and a transmittal letter will be provided separately to the NRR ASP Program liaison (Tanya Mensah).

Event summary. This event involves the entrainment of debris in the emergency service water (ESW) system as the result of a deformed strainer basket associated with the Unit 1 East ESW pump. Because of system cross-ties, both the Unit 1 and Unit 2 ESW systems could be affected by this strainer condition. During the August 2001 event, the plant experienced low ESW flow to both the Unit 1 and Unit 2 emergency diesel generator (EDG) heat exchangers as a result of debris clogging of the ESW system.

Final results and uncertainties. This condition resulted in an estimated change in the mean core damage probability (mean ΔCDP) of approximately 1×10^{-5} with an uncertainty range of between 2×10^{-6} and 3×10^{-5} and additional uncertainty due to model assumptions (see uncertainty discussion in the following paragraphs). The dominant sequences associated with this scenario involve a loss of offsite power (LOOP) initiating event, common cause failure of the EDGs due to debris clogging of the ESW system, and failure to recover offsite power before battery depletion.

The results of this analysis are conditional on modeling assumptions and on the data used to support the risk estimation. This analysis considered parameter and modeling uncertainties as described below.

- Parameter Uncertainty

  The parameter values for equipment performance and human performance used in the risk model and the uncertainties regarding these values (parameter uncertainty) are estimated using generic industry data adjusted for plant-specific operating experience and design features. These data and uncertainty distributions are then propagated through the Standardized Plant Analysis Risk (SPAR) model to produce a mean value of the ΔCDP as well as the 5^{th} and 95^{th} percentile values (see Figure 1). From Figure 1, it can be seen that the mean ΔCDP is approximately 1×10^{-5} for the best estimate case, and that there is a 90% confidence that the ΔCDP is between 1.6×10^{-6} and 2.6×10^{-5}. Consistent with previous ASP practices, the significance of the precursor is determined using the mean value of the uncertainty distribution.

  Note: The "best estimate" case in Figure 1 represents the scenario where the probability of debris entrainment in the ESW system was estimated to be 0.3, and the probability of EDG failure as a result of the entrainment was estimated to be 0.5 per diesel for the Unit 1 EDGs and 0.25 per diesel for the Unit 2 EDGs. The ΔCDP for this case is estimated using a dual unit loss of offsite power initiator, and multiple diesel failure combinations and associated operator recovery probabilities. Attachment 1 provides a more detailed description of the models used and the basis for the input values to the models.

- Model Uncertainty

  The issue of alternative model assumptions (often referred to as model uncertainty) is handled by performing sensitivity studies. Sensitivity cases were performed for debris entrainment probabilities of 0.09 and 0.5. [The probability of 0.09 is based on the final Significance Determination Process (SDP) estimate, and the probability of 0.5 is based on the original SDP estimate as determined by information obtained from NRR analysts and the Resident Inspector.] In addition, sensitivity cases were also performed for EDG failure probabilities of 0.5 per diesel and 0.25 per diesel for all four EDGs. [These probabilities are based on the different interpretations of EDG operability during the August 2001 event.] Figure 2 shows the mean ΔCDP for each of these sensitivity cases. As can be seen, these mean ΔCDP values, which range from 2.6×10^{-6} to 2.5×10^{-5}, are within the bounds for the parameter uncertainty for the best estimate case discussed above.

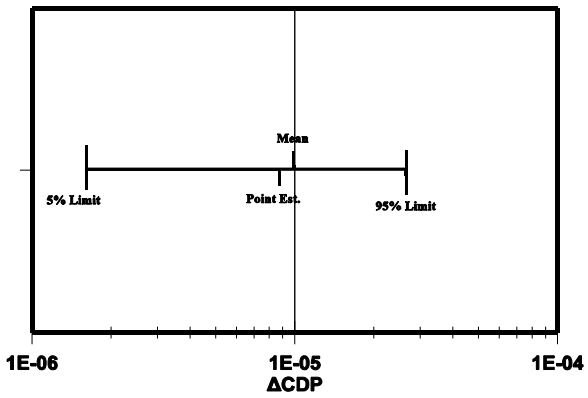

Figure 1- ΔCDP distribution for the best-estimate case

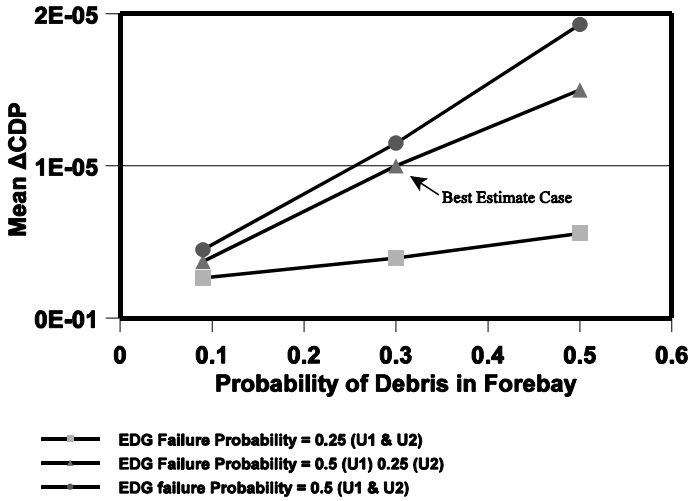

Figure 2- Mean ΔCDPs for the sensitivity cases

SDP/ASP comparison. The event has also been analyzed under the SDP which estimated an increase in core damage frequency of 2.4×10^{-6} (a white finding). As mentioned previously, the ASP evaluation resulted in a mean ΔCDP of 1×10^{-5} for the best-estimate case, with a uncertainty range of between 1.6×10^{-6} and 2.6×10^{-5}. Therefore, the SDP result is within the uncertainty bounds of the ASP results.

The differences between the results from the SDP and ASP are the result of several factors for which additional information was obtained and analysis performed as part of the ASP process. These differences, which are summarized below, have been discussed with staff analysts in NRR and in Region III.

- Accident Scenarios Modeled

  The accident scenario analyzed in the SDP is a dual unit LOOP with failure of all four EDGs. Using a failure probability of 0.5 per diesel, the frequency of occurrence for this accident scenario was estimated by multiplying the frequency of a dual unit LOOP by the common cause failure probability of 0.06 for the four EDGs.

  The dual unit LOOP was also the initiating event modeled in the ASP analysis. However, in addition to the accident scenario where all four EDGs are failed by the debris entrainment, the ASP analysis also included accident scenarios where debris entrainment only fails 3 of the 4 EDGs, 2 of the 4 EDGs, and 1 of the 4 EDGs. The total ΔCDP is the sum of each of these individual scenarios weighted by their probability of occurrence.

  Results from the best estimate ASP analysis for Unit 1 show that the scenario where all four EDGs fail contributes only about 10 percent of the total ΔCDP. The scenario where there are two EDG failures (but with both failures in Unit 1) contributes about 45 percent of the total ΔCDP. The scenario where there are three EDG failures (with two failures in Unit 1 and one in Unit 2) contributes about 38 percent of the total ΔCDP. The remaining combinations of EDG failures contribute about 7 percent of the ΔCDP.

  This factor represents a relatively large difference between ASP and SDP results.

- Debris Entrainment Probability

  The SDP evaluation estimated the probability of debris entrainment in the ESW system to be 0.09 based on a combination of engineering analysis and engineering judgement.

  Based on a review of the engineering analyses and judgements performed as part of the SDP, and on discussions with the NRR plant systems engineers and the D.C. Cook Resident Inspector, it was determined that the 0.09 probability for debris entrainment may be somewhat optimistic. A review of plant operating history revealed recurrent problems with debris carryover to the pump-side of the traveling screens, and documented diver inspection results do not support the assumption that the debris inventory in August 2001 was unique. It was also noted that there is some dependency

between the modeled dual-unit LOOP initiating event and the high winds / high wave action that would be more likely to entrain debris in the forebay. In addition, operating experience at D.C. Cook from 1996 until May 2002 revealed that, in 3 of the10 reactor trips at the plant, there was sufficient silt or debris injection into the ESW or other plant systems that resulted in system and/or plant perturbations. A debris entrainment probability of 0.3 was derived from an analysis of operating data at the site.

The sensitivity of the ΔCDP to this parameter is shown in Figure 2. This parameter represents a moderate difference between ASP and SDP results.

- EDG Failure Probability

  Given debris entrainment, the SDP estimation of the EDG failure probability is 0.5 per diesel based on ESW flow rates recorded during the August 2001 event.

  The ASP analysis also used a failure probability of 0.5 for the Unit 1 EDGs. However the probability of failure of the Unit 2 EDGs was determined to be less likely (estimated to be 0.25) for the following reason. During the August 2001 event, one of the two Unit 2 ESW pumps was not started. Since both Unit 1 ESW pumps were operating during that event, it was postulated that the flow differential between the Unit 1 and Unit 2 ESW headers facilitated debris migration from the failed Unit 1 strainer to the Unit 2 ESW header and the Unit 2 EDG coolers. Based on this information, with all four ESW pumps operating during a hypothetical dual unit LOOP event, it is estimated that the amount of debris dispersion onto the Unit 2 side from a failed Unit 1 strainer would be half as much as the debris dispersion onto the Unit 1 side.

  The sensitivity of the ΔCDP to this parameter is shown in Figure 2. This parameter represents a relatively small difference between the ASP and SDP results.

- Credit for Operator Recovery

  The SDP analysis credited operator recovery of clogged EDG coolers, with a non-recovery probability estimated to be 0.13.

  The ASP analysis also took credit for this recovery. However, the human error probabilities (HEPs) used were slightly different, and these HEPs depend on the accident scenario modeled. In the case of failure of all four EDGs, the ASP analysis used an estimated HEP of 0.4 based on the relatively short amount of time available for recovery, the high stress involved, and also based on the fact that, in this station blackout sequence, the unavailability of power will severely hamper operator actions to flush the EDG coolers or to cycle the ESW valves. The HEP for the scenarios where either two or three EDGs are failed was estimated to be 0.22, and the HEP for the scenario where only one diesel is failed by the debris intrusion was estimated to be 0.07. The SPAR human reliability analysis methodology and worksheets were used for these HEP calculations.

> The ΔCDP is not very sensitive to this parameter. For example, if all HEPs were set equal to 0.13, the mean ΔCDP for the best estimate ASP case would be 6×10^{-6}, about a factor of 2 less than the nominal value of 1×10^{-5}.

Sensitive information. This ASP analysis is classified as "SENSITIVE - NOT FOR PUBLIC DISCLOSURE." This classification is based on the guidance provided by the EDO in the memorandum to the Commission (dated April 4, 2002) concerning the release of information to the public that could provide significant assistance to support an act of terrorism. In particular, Criteria 1 was determined to apply to ASP analysis reports:

> Plant-specific information, generated by NRC, our licensees, or our contractors, that would clearly aid in planning an assault on a facility. An example might be drawings depicting the location of certain safety equipment within plant buildings. Examples may include portions of Final Safety Analysis Reports (FSARs), Individual Plant Examination (IPE) material, and other risk and facility vulnerability information.

This classification could change in the future based on revised Agency guidance and office (NRR and RES) procedures in response to the Staff Requirements Memorandum, "Staff Requirements - COMSECY-02-0015 - Withholding Sensitive Homeland Security Information From the Public," dated April 4, 2002. Future changes in the transmittal of ASP analyses will be coordinated with the NRR ASP Program liaison.

The final ASP analysis and the responses to comments can be found at ML033520521.

If you have any questions about the analysis, please contact Eli Goldfeiz (415-5539). For questions concerning the transmittal letter, the ASP Program peer review process, or the release of sensitive information issue, please call Don Marksberry (415-6378).

MEMORANDUM DATED: 12/23/03

SUBJECT: TRANSMITTAL OF FINAL ASP ANALYSIS OF AUGUST 2001 OPERATIONAL CONDITION AT D. C. COOK

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1. Eli Goldfeiz - Prepare transmittal package **(Analyst)**	EBG	12/18
2. Mike Cheok - Concur	MCC	12/19
3 Pat Baranowsky -Concur	PWB	12/22
4. Scott Newberry - Signature	SFN	12/23
5. Nancy - Distribute (provide advanced copies for Marsh and Mensah from Eli) **Fill in Template # and Accession #**	NLL	12/23

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REMARKS

TRANSMITTAL OF FINAL ASP ANALYSIS OF MARCH 2002 OPERATIONAL CONDITION AT D.C. COOK

FROM: (Name, org. symbol, Agency/Post)	Room # - Bldg.
Eli Goldfeiz	Phone # 415-5539