ANALYSIS GROUP TECHNICAL REPORT

SAFETY AND AVAILABILITY ASSESSMENT

NMP1 Probable Maximum Precipitation (PMP) External Flood Risk - Diesel Generator Rooms

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1.0 Background and Objectives

The risk from external flooding was assessed in the NMP1 IPEEE (Reference 1). The risk was judged to be near or below the screening criteria of 1E-6/yr although the analysis was mostly qualitative. The NRC asked for additional information (Reference 2) regarding the potential impact on flooding; NMPC response (Reference 3) provided additional information. Now NRC has asked (Reference 4) specifically that NMPC re-evaluate core damage frequency (CDF) due to PMP flooding of the diesel generator rooms based on their observation that CDF could be approaching 1E-4/yr.

The objectives of this analysis are as follows:

- Provide a simplified analysis of CDF due to the PMP to more clearly communicate why CDF is not approaching 1E-4/yr.
- Use the simplified analysis to support sensitivity analysis and decision-making with regard to further protecting the diesel generators during a PMP event.

2.0 Results and Conclusions

The base case analysis in Section 3 indicates that CDF is less than 1E-6/year. As described, this is judged to be conservative. Sensitivity analyses were performed to investigate the importance of assumptions and support a decision on whether to pursue further analysis and/or plant changes. The following summarizes the base case result (see Section 3) and sensitivities to the base case (changes in failure probability shown in base case):

Case	CDF (/yr)	Discussion
Base Case	6.0E-07	-
PMP 1E-04 to 1E-05	6.0E-08	Extreme flood levels (>1'7" above grade) may be less likely than presented here, as indicated by values used in a study for another plant (Ref. 6).
LOP (0.1 to 0.5)	3.0E-06	The analysis is very sensitive to the conditional probability of AC power loss.
CUL (0.5 to 0.1)	1.2E-07	Site flood levels and impacts are sensitive to culvert blockage assumptions.
DOOR (1 to 0.1)	6.4E-08	Analysis and/or procedures that ensure that flooding does not impact EDGs can significantly reduce risk.
EDG (0.5 to 0.1)	1.2E-07	More detailed analysis of circuit impacts due to PMP could significantly increase the reliability of EDG recovery.

Based on the results presented here, the CDF associated with PMP floods is less that 1.0E-06/yr.

3.0 Analysis

A simplified analysis of the 1E-4/yr PMP event is provided to allow a more quantitative assessment of core damage frequency potential as well as assess the sensitivity of assumptions and our state of knowledge. The event tree below is used to represent key aspects and uncertainties of the event and show the frequency (freq) of each scenario (#). Then, based on the impact of each scenario (Impact), a conditional core damage probability (CCDP) is calculated from the NMP1 PRA (Reference 5). This is documented below and in Attachment 1. Core damage frequency (CDF) is the product of sequence frequency (freq) and CCDP.

PMP	LOP	CUL	DOOR	EDG	#	freq	Impact	CCDP	CDF
0.0001					1	4.5E-05	261-3, scram	1.1E-07	5.0E-12
		0.50			2	0.0E+00	<261-7, scram	1.1E-07	0.0E+00
			1.00		3	2.3E-05	261-9, scram	1.1E-07	2.5E-12
				0.50	4	2.3E-05	261-9, scram*EDGs	1.8E-06	4.1E-11
	0.10				5	5.0E-06	261-3, losp	4.0E-04	2.0E-09
		0.50			6	0.0E+00	<261-7, losp	4.0E-04	0.0E+00
			1.00		7	2.5E-06	261-9, losp	4.0E-04	1.0E-09
				0.50	8	2.5E-06	261-9, losp*EDGs	2.4E-01	6.0E-07
							Total CDF		6.0E-07

PMP = probable maximum precipitation coincident with historical maximum lake level
LOP = no loss of offsite AC power during PMP
CUL = culvert blockage is ~25% or sufficiently low to prevent EDG impact
DOOR = EDG door is closed and/or procedures ensure no EDG impact
EDG = EDG is recovered

The above event tree and analysis represents our judgment and present state of knowledge regarding CDF risk. The results of several sensitivities are provided in Section 2 above.

Each of the above event tree top events is described below with regard to the above scenarios, top event probability, and how they impact the plant and the PRA calculation of CCDP.

PMP - probable maximum precipitation coincident with historical maximum lake level
This is the PMP initiating event defined as those meteorological conditions necessary to cause external flooding at the emergency diesel generator doors that exceed El 261-7. El 261-9 was identified as the PMP flood level in the IPEEE, but subsequent modifications and field inspections indicated that electrical connections that impact the ability of the diesel to start and run are located on terminal strips located at approximately El 261-7 to 261-8. Thus, for this analysis, PMP is the annual frequency of exceeding El 261-7.

The PMP frequency used here is 1.0E-04/yr. This frequency was also cited in the original RAI response (Reference 3) and is believed to be conservative.

LOP – no loss of offsite AC power during PMP
The failure branch is the conditional probability that offsite AC power is lost during the PMP. In the PRA, this probability is <1E-3 over 24 hours given that offsite power was not the initiating event. During the PMP, this probability is higher. A 90% probability of success is provided as the base case.

- LOP success – significantly improves the probability of successful plant operation or shutdown. The analysis conservatively assumes that the plant is tripped or undergoing a shutdown transient (SCRAM initiating event in PRA). With normal AC power available, failure of the EDGs is less important as shown in Sequence 4.

- LOP failure – balance of plant (main condenser and feedwater) is lost. EDGs and relief valves are challenged. The analysis (PRA analysis of CCDP) conservatively assumes a LOSP initiating event with no recovery. As shown, these sequences are more important.

CUL – culvert blockage is ~25% or sufficiently low to prevent EDG impact
Site flood levels due to the PMP event are sensitive to culvert blockage assumptions. Therefore, this top event is included to show the sensitivity of these assumptions. Success indicates that blockage does not cause PMP flood level to reach El 261-7. For example, 25% blockage leads to a El 261-3 PMP flood level. Failure at this top event indicates blockage is sufficient to ensure that PMP flood level reaches El 261-7. The 261-9 flood level is based on 50% blockage. Storm drains are conservatively assumed plugged for both cases of culvert plugging. A 50% probability of success is provided as the base case. This is judged to be conservative. 76/c

DOOR – EDG door is closed and/or procedures ensure no EDG impact
Ensuring that the EDG rollup doors are closed or preventing in leakage can mitigate the whole question of PMP impact on EDGs. Therefore, this top event is included to show the sensitivity of ensuring success (e.g., detailed analysis and/or plant changes) at this top event. Success indicates that flood levels remain below El 261-7. Failure indicates that flood levels exceed El 261-7.

There are leakage paths around the diesel foundation to El 250. It is possible that leakage through this leakage path and around the rollup door to El 250 would prevent a El 261-7 flood level. The PMP event is not a long duration event; thus timing and duration of leakage through the door versus leakage to El 250 is important. Since this analysis has not been performed, a 0% probability of success (guaranteed failure) is provided as the base case. Also, there is no procedural guidance that requires the doors to be closed during the event.

A sensitivity case is described in section 2 relative to the potential decrease in CDF.

EDG – EDG is recovered

Given that EDGs fail due to the flood, there is some probability that one can be recovered in time to prevent core damage. The time available depends on subsequent failures in the PRA. An emergency condenser success path (no dependency on AC power) allows several hours to recover; the PMP event has come and gone. A conservative 50% chance of success is provided as the base case.

Failure at top event EDG is treated as an irrecoverable failure of both EDGs in the PRA calculations of CCDP.

4.0 References

1. Francisco et al., Nine Mile Point Nuclear Station Unit 1 Individual Plant Examination for External Events (SAS-TR-96-001), August, 1996
2. NRC Letter dated March 1998 – RAI relative to NMP1 IPEEE
3. NMPC Letter dated May 18, 1998 (NMP1L 1318) - Response to NRC RAI
4. NRC Letter dated March 1999 – RAI relative to NMP1 IPEEE
5. Kirchner et al., Nine Mile Point Nuclear Station Unit 1 Individual Plant Examination, Rev. 0, Niagara Mohawk Power Corporation, July 1993
6. Haddam Neck Plant, Individual Plant Examination for External Events (HNP IPEEE), Pages 5-13 to 5-14, December, 1994 by Northeast Utilities Services Company.

Attachment 1 – RISKMAN PRA Calculations

Case 1 – SCRAM Initiator

CCDP for sequences 1 through 3 is based on SCRAM initiator set at 1.0/year and quantifying CDF with a 1E-12 cutoff.

Result; CCDP = 1.1E-07

Case 2 – SCRAM (1.0/year) Initiator and EDGs Failed

CCDP for sequence 4 is based on SCRAM initiator set at 1.0/year and the following model changes; CDF quantified with a 1E-12 cutoff:

Top event A2 in SUP1 event tree set to failure (A2F) if normal AC fails (KA=F)
Top event A3 in SUP1 event tree set to failure (A3F) if normal AC fails (KB=F)
Top event EDG in SBO tree set to failure (EDGF) to ensure no recovery
Result; CCDP = 1.8E-06

Case 3 – LOSP (1.0/year) Initiator

CCDP for sequences 5 through 7 is based on LOSP initiator set at 1.0/year and the following model changes; CDF quantified with a 1E-12 cutoff:

Top event OGR in SUP1 event tree set to failure (OGRF) to ensure no recovery
Top event OSP in SBO event tree set to failure (OSPF) to ensure no recovery
Result; CCDP = 4.0E-04

Case 4 – LOSP (1.0/year) Initiator and EDGs Failed

CCDP for sequence 8 is based on LOSP initiator set at 1.0/year and the following model changes; CDF quantified with a 1E-12 cutoff:

Top event OGR in SUP1 event tree set to failure (OGRF) to ensure no recovery
Top event A2 in SUP1 event tree set to failure (A2F)
Top event A3 in SUP1 event tree set to failure (A3F)
Top event EDG in SBO event tree set to failure (EDGF) to ensure no recovery
Top event OSP in SBO event tree set to failure (OSPF) to ensure no recovery
Result; CCDP = 0.25

ENCLOSURE 2