Constellation Energy
Nine Mile Point Nuclear Station

P.O. Box 63
Lycoming, New York 13093

December 6, 2004
NMP1L 1894

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

SUBJECT: Nine Mile Point Units 1 and 2
Docket Nos. 50-220 and 50-410
Facility Operating License Nos. DPR-63 and NPF-69

License Renewal Application – Responses to NRC Requests for Additional Information Regarding the Analysis of Severe Accident Mitigation Alternatives (TAC Nos. MC3274 and MC3275)

Gentlemen:

By letter dated May 26, 2004, Nine Mile Point Nuclear Station, LLC (NMPNS) submitted an application to renew the operating licenses for Nine Mile Point Units 1 and 2, including the Environmental Report – Operating License Renewal Stage (ER).

In a letter dated October 20, 2004, the NRC requested additional information regarding the analysis of severe accident mitigation alternatives (SAMAs) that is described in Section 4.16 of the ER. The NMPNS responses to these requests for additional information are provided in Attachments 1 and 2. Attachment 3 provides a list of the regulatory commitments associated with this submittal.

If you have any questions about this submittal, please contact Peter Mazzaferro, NMPNS License Renewal Project Manager, at (315) 349-1019.

Very truly yours,

James A. Spina
Vice President Nine Mile Point

JAS/DEV/jm

A107

STATE OF NEW YORK :
: TO WIT:
COUNTY OF OSWEGO :

I, James A. Spina, being duly sworn, state that I am Vice President Nine Mile Point, and that I am duly authorized to execute and file this supplemental information on behalf of Nine Mile Point Nuclear Station, LLC. To the best of my knowledge and belief, the statements contained in this submittal are true and correct. To the extent that these statements are not based on my personal knowledge, they are based upon information provided by other Nine Mile Point employees and/or consultants. Such information has been reviewed in accordance with company practice and I believe it to be reliable.

Subscribed and sworn before me, a Notary Public in and for the State of New York and County of Oswego, this 6th day of December, 2004.

WITNESS my Hand and Notarial Seal:

Notary Public

My Commission Expires:

12-6-04
Date

SANDRA A. OSWALD
Notary Public, State of New York
No. 01OS6032276
Qualified in Oswego County
Commission Expires 10/25/05

Attachment:
1. Responses to NRC Requests for Additional Information (RAI) Regarding the Analysis of Severe Accident Mitigation Alternatives (SAMAs)
2. Probabilistic Risk Assessment Sections Related to the Seismic Model
3. List of Regulatory Commitments

cc: Mr. S. J. Collins, NRC Regional Administrator, Region I
Mr. G. K. Hunegs, NRC Senior Resident Inspector
Mr. P. S. Tam, Senior Project Manager, NRR
Ms. L. C. Fields, Environmental Project Manager, NRR
Mr. J. P. Spath, NYSERDA

ATTACHMENT 1

Nine Mile Point Nuclear Station

Responses to NRC Requests for Additional Information (RAI)

Regarding the Analysis of Severe Accident Mitigation Alternatives (SAMAs)

This attachment provides Nine Mile Point Nuclear Station, LLC (NMPNS) responses to the requests for additional information contained in the NRC letter dated October 20, 2004. Each NRC RAI is repeated, followed by the NMPNS response for Nine Mile Point Unit 1 (NMP1) and/or Nine Mile Point Unit 2 (NMP2), as applicable.

RAI No. 1

The SAMA analysis is based on the most recent version of the Nine Mile Point (NMP) Units 1 and 2 Probabilistic Risk Assessments (PRAs), i.e., U1PRA01B and U2PRA01B, which are modified, consolidated versions of the Individual Plant Examination (IPE) and the IPE for External Events (IPEEE) studies. Provide the following information regarding these PRA models (for both units, unless otherwise specified):

a. Briefly discuss the overall findings of the most recent peer review. Include the date of the review and the version of the PRA reviewed. For any element rated low (e.g., rated less than a 3 on a scale of 1 to 4 or rated a conditional 3) or any A and B Facts and Observations that have not yet been addressed in PRA version PRA01B, briefly discuss the potential impact of the unresolved finding on the results of the SAMA analysis, including SAMA identification and screening.

Response 1a

NMP1

A peer review of the NMP1 Independent Plant Examination (IPE) was performed in March 1998. The Boiling Water Reactor Owners Group (BWROG) Probabilistic Safety Assessment (PSA) Certification observations have been addressed, and the most risk significant observations have been incorporated into the current Probabilistic Risk Assessment (PRA) model. The current PRA model U1PRA01B used for the SAMA evaluations is a consolidation of the IPE and IPE for External Events (IPEEE) conducted for NMP1 and includes numerous model enhancements identified not only by the peer review but also by the Nine Mile Point (NMP) PRA Group and in the NRC's IPE and IPEEE Safety Evaluation Reports (SERs).

NMP2

A peer review of the NMP2 IPE was performed in April 1997. The BWROG PSA Certification observations have been addressed, and the most risk significant observations have been incorporated into the current PRA model. The current PRA model U2PRA01B used for the SAMA evaluations is a consolidation of the IPE and IPEEE conducted for NMP2 and includes numerous model enhancements identified not only by the peer review but also by the NMP PRA Group and in the NRC's IPE and IPEEE SERs.

b. *Provide a more detailed and specific breakdown of the contributors to CDF and LERF than provided in the figures and text of Sections F.1.3 and F.1.4. Include for example, the various initiating event contributors to the "Loss of Injection" function sequences, the support system failures contributing to the "Support System Failure" core damage frequency (CDF) and large early release frequency (LERF), the major sequences contributing to the fire CDF (Unit 1), and the specific sequences contributing to the seismic LERF (Unit 1). Also, confirm that the reported CDF and LERF values are mean values.*

Response 1b

NMP1

Table 1b-1 provides a more detailed breakdown of the initiating event contribution to NMP1 core damage frequency (CDF) and large early release frequency (LERF). Note that all PRA values used are considered to be mean values unless otherwise noted. Discussion of dominant fire CDF sequences and dominant seismic LERF sequences follows this table. Note that the values given in Table 1b-1 do not necessarily match exactly the pie charts in License Renewal Application (LRA) ER Section F.1.3. This is due to differences in the grouping of data relating to issues such as rounding.

Table 1b-1
NMP1 Support System Initiating Event Contribution Summary

Initiator ID	Initiator Description	Initiator Frequency (per year)	CDF (per year)	LERF (per year)
BLOSP	SBO MODEL-LOSS OF OFFSITE POWER	3.0E-02	2.0E-06	2.1E-07
ASX	LOSS OF INSTRUMENT AIR	3.0E-02	1.3E-06	1.5E-07
RWX	LOSS OF RBCLC	8.4E-03	5.6E-07	1.5E-08
BD1X	BLACKOUT LOSS OF BATTERY BOARD (BB) 11	6.7E-03	4.9E-07	3.2E-08
D1X	LOSS OF BB11	6.7E-03	4.5E-07	1.1E-08
D2X	LOSS OF BB12	6.7E-03	3.8E-07	9.4E-09
R1X	LOSS OF RPS BUS 11	5.2E-03	3.1E-07	9.8E-10
R2X	LOSS OF RPS BUS 12	5.2E-03	3.1E-07	9.2E-10

Initiator ID	Initiator Description	Initiator Frequency (per year)	CDF (per year)	LERF (per year)
A3X	LOSS OF POWER BOARD (PB) 103	2.0E-02	2.9E-07	1.0E-09
LOSP	LOSS OF OFFSITE POWER	3.0E-02	2.9E-07	4.3E-09
A2X	LOSS OF PB102	2.0E-02	2.6E-07	6.5E-10
LKX	LOSS OF LAKE INTAKE	3.1E-04	1.1E-07	3.4E-10
S1X	LOSS OF SERVICE WATER PUMP	1.5E-01	7.4E-08	1.4E-09
BD2X	BLACKOUT LOSS OF BB12	6.7E-03	7.0E-08	2.0E-08
AD1X	ATWS LOSS OF BB11	6.7E-03	6.7E-08	3.7E-08
AD2X	ATWS LOSS OF BB12	6.7E-03	6.7E-08	3.7E-08
AR1X	ATWS LOSS OF RPS BUS 11	5.2E-03	5.3E-08	2.9E-08
AR2X	ATWS LOSS OF RPS BUS 12	5.2E-03	5.3E-08	2.9E-08
BS1X	SBO MODEL-LOSS OF SERVICE WATER PUMP	1.5E-01	4.1E-08	4.6E-09
AS1X	ATWS MODEL-LOSS SERVICE WATER PUMP	1.5E-01	2.1E-08	1.1E-08
ALOSP	ATWS MODEL-LOSS OF OFFSITE POWER	3.0E-02	1.6E-08	7.3E-09
AASX	ATWS MODEL-LOSS OF INST AIR	3.0E-02	1.2E-08	5.5E-09
BA3X	SBO MODEL-LOSS OF PB103	2.0E-02	1.2E-08	8.7E-10
BB2X	BLACKOUT LOSS OF PB12	2.3E-03	1.2E-08	1.7E-10
BB1X	BLACKOUT LOSS OF PB11	2.3E-03	1.1E-08	1.2E-10
B1X	LOSS OF PB11	2.3E-03	1.0E-08	2.6E-10
BA2X	SBO MODEL-LOSS OF PB102	2.0E-02	1.0E-08	8.1E-10
BASX	SBO MODEL-LOSS OF INSTRUMENT AIR	3.0E-02	7.4E-09	8.3E-10
AA3X	ATWS MODEL-LOSS OF PB103	2.0E-02	6.6E-09	3.5E-09
AA2X	ATWS MODEL-LOSS OF PB102	2.0E-02	6.1E-09	3.3E-09
BLKX	SBO MODEL-LOSS OF LAKE INTAKE	3.1E-04	5.0E-09	2.8E-10
ARWX	ATWS MODEL-LOSS OF RBCLC	8.4E-03	3.6E-09	1.7E-09
BR2X	BLACKOUT LOSS OF RPS BUS 12	5.2E-03	2.0E-09	1.9E-10
BRWX	SBO MODEL-LOSS OF RBCLC	8.4E-03	1.9E-09	2.0E-10
BTWX	SBO MODEL-LOSS OF TBCLC	7.7E-03	1.7E-09	1.9E-10
BR1X	BLACKOUT LOSS OF RPS BUS 11	5.2E-03	1.3E-09	1.3E-10
BA1X	BLACKOUT LOSS OF PB101	4.5E-03	1.2E-09	1.0E-10
ATWX	ATWS MODEL-LOSS OF TBCLC	7.7E-03	1.1E-09	4.3E-10
B2X	LOSS OF PB12	2.3E-03	1.1E-09	2.6E-12
TWX	LOSS OF TBCLC	7.7E-03	7.2E-10	0.0E+00
AA1X	ATWS LOSS OF PB101	4.5E-03	4.6E-10	2.4E-10
A1X	LOSS OF PB101	4.5E-03	3.1E-10	0.0E+00
AB2X	ATWS LOSS OF PB12	2.3E-03	2.9E-10	1.1E-10
AB1X	ATWS LOSS OF PB11	2.3E-03	2.6E-10	1.0E-10
ALKX	ATWS MODEL-LOSS OF LAKE INTAKE	3.1E-04	9.5E-11	1.4E-11
Total Reported Frequencies of the Group:			8.70E-06	6.40E-07

Table 1b-2 provides a more detailed breakdown of the loss of injection sequence for NMP1 CDF and LERF. For CDF, these were derived by totaling the contribution from the following end states: CLASS1A, CLASS1D, CLASS1M, CLASS3B, CLASS3C, and CLASS5. For LERF, this grouping was not presented in the tables referenced in the RAI question. However, they are included for additional information. Note that all PRA values used are considered to be mean values unless otherwise noted. Note also that the values given in Table 1b-2 do not necessarily match exactly the pie charts in LRA ER Section F.1.3. This is due to differences in the grouping of data relating to issues such as rounding.

Table 1b-2
NMP1 Event Contribution to "Loss of Injection" Group

Initiator ID	Initiator Description	Initiator Frequency (per year)	CDF (per year)	LERF (per year)
FT3B1	FIRE IN T3B #1	1.4E-04	3.5E-06	2.4E-08
FT3B3	FIRE IN T3B #3	1.0E-04	2.5E-06	1.7E-08
FC11	FIRE IN C1 #1	1.0E-05	1.5E-06	1.8E-08
FC31	FIRE IN C3 #1	9.2E-06	1.5E-06	1.8E-08
ASX	LOSS OF INSTRUMENT AIR	3.0E-02	1.2E-06	1.5E-07
FT2B4	FIRE IN T2B #4	4.6E-06	7.8E-07	9.3E-09
SEIS4	EPRI SEISMIC HAZARD (0.25 TO 0.51G)	6.2E-06	6.0E-07	3.1E-07
FT2D1	FIRE IN T2D	5.0E-04	5.1E-07	5.8E-09
FC23	FIRE IN C2 #3	1.2E-05	3.8E-07	4.6E-09
FT2B1	FIRE IN T2B #1	7.0E-04	3.5E-07	4.2E-09
FC24	FIRE IN C2 #4	2.1E-04	3.4E-07	3.2E-09
D1X	LOSS OF BB11	6.7E-03	3.3E-07	1.1E-08
FC35	FIRE IN C3 #5	2.0E-04	3.1E-07	3.0E-09
R1X	LOSS OF RPS BUS 11	5.2E-03	3.1E-07	9.8E-10
R2X	LOSS OF RPS BUS 12	5.2E-03	3.1E-07	9.2E-10
SCRAM	SCRAM - NO RPS CHALLENGE	4.8E+00	3.0E-07	6.9E-09
A3X	LOSS OF PB103	2.0E-02	2.6E-07	1.0E-09
A2X	LOSS OF PB102	2.0E-02	2.4E-07	6.5E-10
SEIS3	EPRI SEISMIC HAZARD (0.1 TO 0.25)	6.6E-05	2.0E-07	8.2E-08
SEIS5	EPRI SEISMIC HAZARD (0.51 TO 0.71)	5.1E-07	2.0E-07	1.1E-07
FT3B2	FIRE IN T3B #2	6.0E-06	1.7E-07	1.2E-09
FT2A1	FIRE IN T2A	3.6E-04	1.3E-07	1.7E-09
ISLOC	ISLOCA	2.6E-06	1.3E-07	1.3E-07
RWX	LOSS OF RBCLC	8.4E-03	1.2E-07	1.5E-08
D2X	LOSS OF BB12	6.7E-03	1.2E-07	9.4E-09
FC21	FIRE IN C2 #1	3.5E-06	1.1E-07	1.2E-09
TLOF	TOTAL LOSS OF FEEDWATER	5.0E-02	1.1E-07	5.2E-09
XLOCA	EXCESSIVE LOCA	1.0E-07	9.9E-08	2.5E-09
SLOCW	SMALL LOCA WATER	4.0E-03	8.8E-08	6.5E-09

Initiator ID	Initiator Description	Initiator Frequency (per year)	CDF (per year)	LERF (per year)
MSIV	ALL MSIVs CLOSE	2.0E-01	8.4E-08	4.7E-09
TT	TURBINE TRIP	1.3E+00	8.1E-08	1.5E-09
SEIS6	EPRI SEISMIC HAZARD (0.71 TO 1)	1.4E-07	7.2E-08	4.0E-08
FC22	FIRE IN C2 #2	1.7E-06	6.7E-08	1.1E-08
LOSP	LOSS OF OFFSITE POWER	3.0E-02	6.4E-08	4.3E-09
RPS	SCRAM RPS CHALLENGE	1.0E+00	6.1E-08	1.2E-09
FC12	FIRE IN C1 #2	4.6E-06	5.9E-08	6.2E-10
PLOF	LOSS OF 1 FEEDWATER PUMP	1.4E-01	4.6E-08	2.3E-09
FC34	FIRE IN C3 #4	1.4E-05	3.1E-08	1.9E-10
LOC	LOSS OF CONDENSER	5.0E-02	2.2E-08	1.9E-09
S1X	LOSS OF SERVICE WATER PUMP	1.5E-01	1.9E-08	1.4E-09
PMSIV	LOSS OF 1 MSIV PATH	2.3E-01	1.4E-08	1.9E-10
LKX	LOSS OF LAKE INTAKE	3.1E-04	1.1E-08	3.4E-10
MLOCW	MEDIUM LOCA WATER	2.0E-05	6.5E-09	1.3E-09
LLOCW	LARGE LOCA WATER	1.5E-05	4.6E-09	9.5E-10
SEIS2	EPRI SEISMIC HAZARD (5E-2 TO 0.1)	2.9E-04	4.4E-09	4.7E-10
SEIS1	EPRI SEISMIC HAZARD (1E-2 TO 5E-2)	1.5E-02	4.4E-09	2.3E-09
B1X	LOSS OF PB11	2.3E-03	3.1E-09	2.6E-10
FC33	FIRE IN C3 #3	4.6E-06	2.7E-09	1.1E-11
FC32	FIRE IN C3 #2	4.6E-06	2.3E-09	7.7E-12
IORV	INADVERTENT OPEN ERV	2.0E-02	1.5E-09	3.0E-12
TWX	LOSS OF TBCLC	7.7E-03	3.8E-10	0.0E+00
B2X	LOSS OF PB12	2.3E-03	3.3E-10	2.6E-12
A1X	LOSS OF PB101	4.5E-03	1.8E-10	0.0E+00
MLOCS	MEDIUM LOCA STEAM	2.0E-05	1.6E-10	2.7E-12
LLOCS	LARGE LOCA STEAM	1.5E-05	1.1E-10	2.0E-12
SLOCS	SMALL LOCA STEAM	2.5E-04	7.9E-12	0.0E+00
Total Reported Frequencies of the Group:			1.9E-05	1.0E-06

Major NMP1 Fire CDF Sequences:

- CDF Sequence 1, Fire CDF Sequence 1

  A fire in the turbine building (FT3B1=1.4E-04) initiates the sequence. This fire causes a loss of power boards 12, 101, 102, and 103, and battery board 12. Initially, reactor pressure vessel (RPV) inventory control and heat removal are provided (feedwater, main condenser, diesel fire pump, emergency condensers are potentially available for safe shutdown).

  Assuming eventual loss of direct current (DC) and reactor protection system (RPS) buses due to loss of alternating current (AC) supply to chargers, plant operators fail while controlling the cooldown using the East/West instrument rooms per special operating procedures (HRA1=2E-2).

- CDF Sequence 2, Fire CDF Sequence 2

  Another fire location in the turbine building (FT3B3=1.0E-04) initiates the sequence. This fire causes a loss of power boards 101, 102, and 103, and battery board 12. Other than slightly different impacts, this scenario is essentially the same as for the above fire (FT3B1). The operator actions described above for FT3B1 are also the same.

- CDF Sequence 3, Fire CDF Sequence 3

  A fire in the cable spreading room (FC11=1.0E-05) initiates the sequence. This fire causes a loss of all AC power (PB101, 102, 103, 11, and 12 fail). Then, the diesel fire pump fails (FP2=0.103) which eventually leads to core damage. The PRA requires a reactor makeup source in the long term even with emergency condensers successful.

- CDF Sequence 4, Fire CDF Sequence 4

  This sequence is the same as sequence 3 except the fire is in the control room (FC31=9.2E-06).

- CDF Sequences 7 and 8, Fire CDF Sequences 5 and 6

  These sequences are similar to CDF sequences 3 and 4, except a reactor recirculation pump seal loss of coolant accident (LOCA) (NSL1=0.05) occurs due to loss of cooling. The PRA does not allow recovery of these sequences if LOCA conditions develop.

Major NMP1 Seismic LERF Sequences:

- LERF Sequence 1, Seismic LERF Sequence 1

  A relatively large earthquake, EPRI SEISMIC HAZARD (0.25 TO 0.51G), initiates the sequence (SEIS4=6.2E-06). Equipment failures due to the earthquake (COMP2) cause core damage (COMP24=9.1E-2). Split fraction COMP24 represents seismic common-cause failure of the SMA/A-46 success paths, given the SEIS4 initiator, such that core damage occurs.

In the containment event tree (CET), the RPV fails to be depressurized before breach (OI1=0.455) which, combined with no available water sources (COMP2 failure), creates a high pressure melt induced early-high containment failure sequence.

- <u>LERF Sequence 3, Seismic LERF Sequence 2</u>

  A relatively large earthquake, EPRI SEISMIC HAZARD (0.51 TO 0.71G), initiates the sequence (SEIS5=5.1E-07). Equipment failures due to the earthquake (COMP2) cause core damage (COMP25=0.43). Split fraction COMP25 represents seismic common-cause failure of the SMA/A-46 success paths, given the SEIS5 initiator, such that core damage occurs.

  In the CET, the RPV fails to be depressurized before breach (OI1=0.455) which, combined with no available water sources (COMP2 failure), creates a high pressure melt induced early-high containment failure sequence.

- <u>LERF Sequence 5, Seismic LERF Sequence 3</u>

  A relatively large earthquake, EPRI SEISMIC HAZARD (0.1 TO 0.25G) initiates the sequence (SEIS3=6.6E-5). Equipment failures due to the earthquake (COMP2) cause core damage (COMP23=2.2E-3). Split fraction COMP23 represents seismic common-cause failure of the SMA/A-46 success paths, given the SEIS3 initiator, such that core damage occurs.

  In the CET, the RPV fails to be depressurized before breach (OI1=0.455) which, combined with no available water sources (COMP2 failure), creates a high pressure melt induced early-high containment failure sequence.

- <u>LERF Sequence 6, Seismic LERF Sequence 4</u>

  A relatively large earthquake, EPRI SEISMIC HAZARD (0.25 TO 0.51G), initiates the sequence (SEIS4=6.2E-06). Equipment failures due to the earthquake (COMP1) cause core damage and containment failure (COMP14=9.2E-3). Split fraction COMP14 represents seismic common-cause failure of the SMA/A-46 success paths and primary containment (i.e., massive structural failures), given the SEIS4 initiator, such that core damage and LERF occurs.

- <u>LERF Sequence 6, Seismic LERF Sequence 5</u>

  A relatively large earthquake, EPRI SEISMIC HAZARD (0.51 TO 0.71G), initiates the sequence (SEIS5=5.1E-07). Equipment failures due to the earthquake (COMP1) cause core damage and containment failure (COMP15=0.1). Split fraction COMP15 represents seismic common-cause failure of the SMA/A-46 success paths and primary containment (i.e., massive structural failures), given the SEIS5 initiator, such that core damage occurs.

NMP2

Table 1b-3 provides a more detailed breakdown of the support system initiating event contribution to NMP2 CDF and LERF. Note that all PRA values used are considered to be mean values unless otherwise noted. Note also that the values given in Table 1b-3 do not necessarily match exactly the pie charts in LRA ER Section F.1.4. This is due to differences in the grouping of data relating to issues such as rounding.

Table 1b-3
NMP2 Support System Initiating Event Contribution Summary

Initiator ID	Initiator Description	Initiator Frequency (per year)	CDF (per year)	LERF (per year)
BLOSP	Loss of offsite power – blackout	8.0E-02	3.2E-05	2.8E-07
LOSP	Loss of offsite power – non blackout	8.0E-02	3.3E-06	4.1E-08
ASX	Loss of instrument air	1.4E-01	2.1E-06	5.3E-08
RWX	Loss of RBCLC	6.7E-02	1.1E-06	2.5E-08
A2X	Loss of Division II AC	6.0E-03	1.0E-06	7.5E-09
TWX	Loss of TBCLC	5.8E-02	9.0E-07	2.3E-08
KB1X	Loss of 115 kV line 6	3.3E-01	7.5E-07	1.0E-09
BKB1X	Loss of 115 kV line 6 – blackout	3.3E-01	5.5E-07	3.7E-08
SWPX	Loss of 2 service water pumps	3.0E-03	4.7E-07	4.9E-10
BKA2X	Loss of 115 kV transformer 1A – blackout	5.5E-02	4.2E-07	3.0E-08
A1X	Loss of Division I AC	6.0E-03	4.1E-07	4.2E-09
BKA1X	Loss of 115 kV line 5 – blackout	3.3E-01	3.5E-07	2.3E-08
KB2X	Loss of 115 kV transformer 1B	5.5E-02	2.9E-07	5.0E-10
N2X	Loss of nitrogen	1.7E-02	2.9E-07	6.5E-11
D2X	Loss of Div II DC	2.6E-03	2.6E-07	3.6E-09
BKB2X	Loss of 115 kV transformer 1B – blackout	5.5E-02	2.2E-07	1.6E-08
SAX	Loss of service water header A	3.7E-04	2.1E-07	6.9E-10
BA2X	Loss of Division II AC – ATWS	6.0E-03	2.0E-07	6.6E-09
KA1X	Loss of 115 kV line 5	3.3E-01	1.9E-07	1.3E-09
LKX	Loss of lake intake	1.0E-04	1.6E-07	1.2E-09
BA1X	Loss of Division I AC – ATWS	6.0E-03	1.2E-07	3.1E-09
D1X	Loss of Division I DC power	2.6E-03	1.2E-07	6.1E-09
ALOSP	Loss of offsite power – ATWS	8.0E-02	1.1E-07	1.6E-08
KA2X	Loss of 115 kV transformer 1A	5.5E-02	1.0E-07	5.4E-10
BASX	Loss of instrument air – blackout	1.4E-01	1.9E-08	2.6E-10
XTX	Service water crosstie closure	1.3E-03	9.4E-09	1.3E-12
Total Reported Frequencies of the Group:			4.6E-05	5.8E-07

Table 1b-4 provides a more detailed breakdown of the loss of injection sequence for NMP2 CDF and LERF. For CDF, these were derived by totaling the contribution from the following end states: CLASS1A, CLASS1D, CLASS3B, CLASS3C, and CLASS5. For LERF, this grouping was not presented in the tables referenced in the RAI. However, they are included for additional information. Note that all PRA values used are considered to be mean values unless otherwise noted. Note also that the values given in Table 1b-4 do not necessarily match exactly the pie charts in LRA ER Section F.1.4. This is due to differences in the grouping of data relating to issues such as rounding.

Table 1b-4
NMP2 Event Contribution to "Loss of Injection" Group

Initiator ID	Initiator Description	Initiator Frequency (per year)	CDF (per year)	LERF (per year)
ASX	Loss of instrument air	1.4E-01	1.8E-06	5.3E-08
LOF	Loss of feedwater	1.4E-01	1.8E-06	5.6E-08
LOSP	Loss of offsite power – non blackout	8.0E-02	1.7E-06	4.1E-08
SCRAM	Reactor scram	4.8E+00	1.1E-06	2.9E-08
RWX	Loss of RBCLC	6.7E-02	8.8E-07	2.9E-08
FCR0	Fire in control room – event 0	2.1E-04	7.9E-07	5.2E-09
TWX	Loss of TBCLC	5.8E-02	7.6E-07	2.6E-08
MLOCA	Medium LOCA	3.0E-03	6.3E-07	8.5E-09
A2X	Loss of Division II AC	6.0E-03	6.0E-07	2.0E-08
FCR1	Fire in control room – event 1	1.1E-05	4.6E-07	3.1E-08
A1X	Loss of Division I AC	6.0E-03	3.7E-07	1.7E-08
TT	Turbine trip – non ATWS	1.5E+00	3.3E-07	8.7E-09
FCR2	Fire in control room – event 2	1.1E-05	3.1E-07	2.1E-09
D1X	Loss of Division I DC power	2.6E-03	2.9E-07	6.7E-09
FCR3	Fire in control room – event 3	1.1E-05	2.1E-07	1.3E-09
IORV	Inadvertent/stuck open SRV	2.0E-02	2.0E-07	2.5E-08
SEIS4	Seismic event – hazard level 4	6.2E-06	1.6E-07	5.9E-08
LKX	Loss of lake intake	1.0E-04	1.3E-07	1.6E-09
SEIS1	Seismic event – hazard level 1	1.5E-02	1.1E-07	1.2E-08
D2X	Loss of Div II DC	2.6E-03	1.0E-07	4.3E-09
XLOCA	Excessive LOCA	1.0E-07	9.9E-08	5.1E-10
SEIS3	Seismic event – hazard level 3	6.6E-05	9.4E-08	7.9E-09
KA1X	Loss of 115 kV line 5	3.3E-01	7.9E-08	1.7E-09
KB1X	Loss of 115 kV line 6	3.3E-01	7.3E-08	1.3E-09
SEIS5	Seismic event – hazard level 5	5.1E-07	6.7E-08	5.0E-08
SLOCA	Small LOCA	8.0E-03	5.1E-08	8.8E-09
SEIS6	Seismic event – hazard level 6	1.4E-07	4.6E-08	4.1E-08

Initiator ID	Initiator Description	Initiator Frequency (per year)	CDF (per year)	LERF (per year)
SWPX	Loss of 2 service water pumps	3.0E-03	3.4E-08	6.8E-10
KA2X	Loss of 115 kV transformer 1A	5.5E-02	3.2E-08	6.5E-10
KB2X	Loss of 115 kV transformer 1B	5.5E-02	3.0E-08	5.6E-10
LOC	Loss of condenser	1.4E-01	3.0E-08	6.6E-10
MSIV	All MSIVs close	1.4E-01	3.0E-08	6.6E-10
LLOCA	Large LOCA	7.0E-04	2.5E-08	9.8E-09
FLSWB	Flood – Div II service water pumps	1.0E-03	2.5E-08	1.8E-09
SAX	Loss of service water header A	3.7E-04	2.3E-08	7.2E-10
FNSGR	Fire – normal switchgear room	2.0E-04	2.3E-08	4.0E-10
FA88B	Fire – control building corridor	3.9E-05	2.0E-08	3.7E-10
FLSWA	Flood – Div I service water pumps	1.0E-03	1.6E-08	1.3E-09
N2X	Loss of nitrogen	1.7E-02	1.3E-08	1.0E-09
F336XL	Fire in area F336XL	6.7E-05	1.0E-08	5.5E-10
ISLOCA	Interfacing System LOCA	1.1E-05	9.7E-09	1.7E-09
F338NZ	Fire in area F338NZ	1.5E-04	8.7E-09	6.6E-10
FA16A	Fire in area FA16A	4.5E-05	8.6E-09	5.3E-10
FA18A	Fire in area FA18 – event A	4.5E-05	7.5E-09	3.6E-10
SEIS2	Seismic event – hazard level 2	2.9E-04	5.8E-09	4.7E-10
F343NZ	Fire in area F343NZ	1.5E-04	5.6E-09	4.6E-10
F333XL	Fire in area F333XL	6.7E-05	5.5E-09	3.2E-10
FA16B	Fire in area FA16B	2.3E-06	3.7E-09	5.9E-11
FA18B	Fire in area FA18 – event B	2.3E-06	3.5E-09	3.5E-11
XTX	Service water crosstie closure	1.3E-03	1.2E-09	6.6E-11
Total Reported Frequencies of the Group:			1.4E-05	5.7E-07

c. *The IPEEE utilized a seismic margins method to identify possible seismic vulnerabilities. Although such methods do not typically provide enough information to determine CDF and LERF, quantitative frequency estimates are reported for NMP. Provide more information on the development, assumptions, and results of the current seismic model in the NMP PRA.*

Response 1c

When the IPEEE was performed for NMP1 and NMP2, fragilities were developed along with High Confidence Low Probability of Failures (HCLPFs). The fragilities, site-specific initiating events, and seismic margins shutdown paths were incorporated into the PRA. A seismic event tree is used to establish component failure probabilities from the fragilities prior to linking to the support system and frontline event trees. For more information, see the major sections of the NMP1 and NMP2 PRAs related to the seismic model that are provided in Attachment 2.

d. *It is stated that no major changes were made to the Level 2 evaluations of the IPE. For the models used for the SAMA analysis, please provide a summary of the core damage accident subclass frequencies (similar to Table 4.6-3 of the IPEs) and a summary of the releases versus accident subclass (similar to Table 4.6-5 of the IPEs).*

Response 1d

Tables 1d-1 and 1d-3 provide the requested information for NMP1, and Tables 1d-2 and 1d-4 provide the requested information for NMP2.

Table 1d-1
NMP1 Core Damage End States

Core Damage End State	Accident Sequence Definition	Frequency (per year)
Class IA	Loss of inventory makeup with the RPV at high pressure (transient/small LOCA)	3.0E-06
Class IB	Loss of inventory makeup in the station blackout model	4.9E-06
Class IC	Loss of inventory makeup in the anticipated transients without scram (ATWS) model	5.1E-08
Class ID	Loss of inventory makeup with the RPV at low pressure (transient/small LOCA)	1.4E-05
Class IM	Loss of inventory makeup with the RPV at low pressure (transient/small LOCA) and the main steam isolation valves (MSIVs) are open	4.4E-09
Class IIA	Loss of containment heat removal and core damage induced post containment failure (transient/small LOCA model)	1.8E-06
Class IIT	Loss of containment heat removal and core damage induced prior to containment failure	4.1E-07
Class IIL	Loss of containment heat removal and core damage induced post containment failure (medium and large LOCA model)	5.5E-10
Class IIV	Loss of inventory makeup after containment venting success	1.3E-07
Class IIIB	Loss of inventory makeup in the medium LOCA model with RPV at high pressure	3.6E-10
Class IIIC	Loss of inventory makeup in the medium and large LOCA model with RPV at low pressure	1.1E-07
Class IIID	Vapor suppression failure in the LOCA models fails containment and causes core damage	1.1E-08
Class IVA	Inadequate reactivity control and containment heat removal during an ATWS scenario induces core damage post containment failure	4.5E-07
Class IVL	Inadequate reactivity control causes containment challenge, thereby inducing core damage post containment failure	5.3E-07
Class V	Unisolated LOCA outside containment	1.3E-07

Table 1d-2
NMP2 Core Damage End States

Core Damage End State	Accident Sequence Definition	Frequency (per year)
Class IA	Loss of inventory makeup with the RPV at high pressure (transient and small LOCA models)	7.6E-06
Class IB	Loss of inventory makeup in the station blackout model	3.7E-05
Class IC	Loss of inventory makeup in the ATWS model	2.5E-07
Class ID	Loss of inventory makeup with the RPV at low pressure (transient and small LOCA models)	4.7E-06
Class IIA	Loss of containment heat removal and core damage induced post containment failure (transient and small LOCA models)	4.7E-06
Class IIT	Loss of containment heat removal and core damage induced prior to containment failure (transient and small LOCA models)	5.7E-06
Class IIL	Loss of containment heat removal and core damage induced post containment failure (medium and large LOCA models)	5.7E-07
Class IIIB	Loss of inventory makeup in the medium LOCA model with RPV at high pressure	5.7E-07
Class IIIC	Loss of inventory makeup in the medium and large LOCA models with RPV at low pressure	2.7E-07
Class IIID	Vapor suppression failure in the LOCA models challenge containment and causes core damage	1.5E-08
Class IVA	Reactor power control failure in the transient model challenges containment and induces core damage post containment failure	8.2E-07
Class IVL	Reactor power control failure and LOCA conditions challenges containment and induces core damage post containment failure	6.2E-08
Class V	Interfacing System LOCA outside containment	9.9E-09

Table 1d-3
NMP1 Summary of Release vs. Accident Class

Class	EHGH	IHGH	LHGH	EMED	IMED	LMED	ELO	ILO	LLO	NOREL	Total Release	Total
IA	7.8E-07	1.3E-07	2.5E-08	4.5E-07	8.9E-08	1.2E-06	3.4E-09	1.3E-08	7.5E-09	3.2E-07	2.7E-06	3.0E-06
IB	5.2E-07	1.8E-06	ε	5.2E-07	1.6E-06	ε	ε	3.1E-09	ε	3.7E-07	4.4E-06	4.8E-06
IC	5.1E-09	1.8E-09	ε	5.2E-09	ε	2.4E-09	1.0E-09	ε	ε	3.3E-08	1.6E-08	4.9E-08
ID	1.2E-07	1.1E-06	4.2E-07	6.6E-07	4.7E-06	5.4E-06	2.9E-09	1.6E-07	1.6E-07	2.8E-06	1.3E-05	1.6E-05
IM	ε	ε	ε	ε	ε	ε	ε	ε	ε	ε	ε	ε
IIA	-	-	3.2E-08	-	-	1.1E-06	-	-	5.5E-07	-	1.7E-06	1.7E-06
IIT	-	-	3.0E-07	-	-	8.0E-08	-	-	ε	1.4E-08	3.8E-07	3.9E-07
IIL	-	-	ε	-	-	ε	-	-	ε	-	0.0E+00	0.0E+00
IIV	-	-	4.3E-08	-	-	1.9E-08	-	-	7.0E-08	-	1.3E-07	1.3E-07
IIIB	ε	ε	ε	ε	ε	ε	ε	ε	ε	ε	ε	ε
IIIC	4.8E-09	ε	ε	8.4E-08	ε	ε	1.8E-09	ε	ε	1.9E-08	9.1E-08	1.1E-07
IIID	1.1E-08	ε	ε	ε	ε	ε	ε	ε	ε	-	1.1E-08	1.1E-08
IV	6.1E-07	ε	ε	3.7E-07	ε	ε	ε	ε	ε	-	9.8E-07	9.8E-07
V	1.3E-07	-	-	5.8E-09	-	-	-	-	-	-	1.4E-07	1.4E-07
Total	2.2E-06	3.0E-06	8.2E-07	2.1E-06	6.4E-06	7.8E-06	9.1E-09	1.8E-07	7.9E-07	3.6E-06	2.3E-05	2.7E-05

Notes:
ε is assigned to a total less than 1E-9 (negligible).
- indicates that the class of accident cannot result in the release category.

Table 1d-4
NMP2 Summary of Release vs. Accident Class

Class	EHGH	IHGH	LHGH	EMED	IMED	LMED	ELO	ILO	LLO	NOREL	Total Release	Total
IA	3.6E-07	7.6E-07	ε	1.7E-09	8.3E-08	4.8E-08	5.5E-08	2.3E-08	6.8E-08	6.0E-06	1.4E-06	7.4E-06
IB	5.9E-07	4.1E-06	ε	5.7E-08	1.3E-07	2.4E-09	3.4E-06	2.7E-07	6.1E-09	2.8E-05	8.6E-06	3.7E-05
IC	4.2E-08	7.1E-09	ε	8.4E-09	4.6E-08	ε	1.2E-07	ε	ε	1.9E-08	2.2E-07	2.4E-07
ID	8.6E-08	3.3E-06	1.2E-08	1.1E-08	3.2E-08	7.5E-09	9.4E-08	1.2E-08	4.1E-09	1.4E-06	3.6E-06	5.0E-06
IIA	-	-	2.2E-06	-	-	4.2E-07	-	-	2.0E-06	-	4.6E-06	4.6E-06
IIT	-	-	4.5E-06	-	-	2.6E-07	-	-	8.7E-07	9.3E-09	5.6E-06	5.6E-06
IIL	-	-	1.0E-07	-	-	3.3E-08	-	-	4.4E-07	-	5.7E-07	5.7E-07
IIIB	3.1E-09	ε	ε	ε	ε	ε	8.6E-09	6.0E-09	ε	5.5E-07	1.8E-08	5.7E-07
IIIC	1.3E-08	1.1E-07	ε	ε	5.3E-09	1.1E-09	2.1E-09	3.8E-08	2.9E-09	9.6E-08	1.7E-07	2.7E-07
IIID	1.1E-08	ε	ε	ε	ε	ε	ε	ε	ε	-	1.1E-08	1.1E-08
IV	1.1E-07	ε	ε	7.3E-07	ε	ε	ε	ε	ε	-	8.4E-07	8.4E-07
V	1.7E-09	-	-	8.0E-09	-	-	-	-	-	-	9.7E-09	9.7E-09
Total	1.2E-06	8.3E-06	6.8E-06	8.2E-07	3.0E-07	7.7E-07	3.7E-06	3.5E-07	3.4E-06	3.6E-05	2.6E-05	6.2E-05

Notes:
ε is assigned to a total less than 1E-9 (negligible).
- indicates that the class of accident cannot result in the release category.

e. *Tables F.2-5 and F.2-6 in the Environmental Report (ER) provide the offsite consequences by release category. Describe the criteria used to classify the releases in terms of timing (early, intermediate and late) and magnitude (high, medium, low, no). Identify which release categories are assumed to contribute to LERF.*

Response 1e

The release categories are based on Cesium-Iodine (CsI) release fractions and timing after event initiation based upon the NMP PRA, as follows:

Table 1e-1
Release Categories

ID	Description (Timing - Magnitude)
EHGH	Early – High
IHGH	Intermediate – High
LHGH	Late – High
EMED	Early – Medium
IMED	Intermediate – Medium
LMED	Late – Medium
ELO	Early – Low
ILO	Intermediate – Low
LLO	Late – Low
NOREL	No Release (Leakage)

Table 1e-2
Timing of Releases Following Event Initiation

CsI Magnitude	Time After Event Initiation		
	< 6 hours (Early - E)	6 to 24 hours (Intermediate - I)	24 hour (Late – L)
> 10% (High – HGH)	EHGH	IHGH	LHGH
1 to 10% (Medium – MED)	EMED	IMED	LMED
< 1% (Low – LO)	ELO	ILO	LLO
No release (NOREL)	NOREL		

Note:
The early high (EHGH) release is equivalent to LERF.

f. The Unit 1 IPE technical evaluation report indicates that it is assumed that the core spray pumps can survive up to over 300 deg F with a 0.5 probability. Clarify whether this assumption is still used, and if so, please explain.

Response 1f

The probability of continued RPV injection when operating under degraded containment conditions, up to and including containment failure, is modeled in Top Event CI. Top Event CI includes a basic event "CI________ZZZ21" which represents core spray operating up to and beyond containment failure. This basic event was set equal to 0.5 in the IPE model and remains 0.5 in the current model. As discussed in Section 3.2.1.25 of the IPE submittal (LRA ER Appendix F, Reference F.1-1), operation in these conditions would involve pumping water under saturated conditions. The following failure modes were considered:

- Electrical winding failure caused by seal failure
- Mechanical binding due to thermal expansion

It was judged that operation under such conditions would not necessarily guarantee failure, especially considering that many scenarios include up to four core spray trains available.

Also note that the importance of this aspect of the model, as well as the core spray system in general, has been reduced by Emergency Operating Procedure (EOP) changes. EOPs in place during the IPE included instructions to limit RPV injection to sources inside the primary containment when the Drywell Pressure Limit is exceeded. This direction has been revised to allow external sources needed for core cooling. As such, top event CI has been updated in the PRA model to include feedwater, containment spray raw water injection via core spray, and control rod drive (CRD) flow. In the latest model, the CDF risk achievement worth (RAW) value for the "CI________ZZZ21" basic event is 1.006, which indicates that this modeling has an insignificant impact if it were set to 1.0. Additionally, the CDF risk reduction worth (RRW) is about 1.006, indicating there is an insignificant benefit to reducing this contribution to risk. Also, this is not a contributor to LERF sequences.

RAI No. 2

Section 4.16.3 indicates that an initial list of 207 candidate SAMAs was identified from generic sources and 16 additional SAMAs were identified based on the plant-specific risk profiles for Units 1 and 2. Of this total 13 alternatives for Unit 1 and 20 alternatives for Unit 2 were subjected to cost-benefit analysis. Provide the following information regarding the identification of candidate SAMAs:

a. *Section 4.16.3 of the ER indicates that sequences that contribute more than 1% to CDF or LERF were reviewed in the process of identifying candidate SAMAs. Section F.1.5 describes SAMA candidates based on contributions of 5% or more to CDF (10% for fires). To ensure that the set of SAMAs evaluated address the major risk contributors, provide a list of risk reduction worth (RRW) or Fussel- Vesely (FV) CDF and LERF importance values for systems, functions and operator actions. Discuss SAMAs for sequences that contribute between 1% and 5% of CDF (between 1% and 10% for fires) and whether they could be cost beneficial.*

Response 2a

Tables 2a-1 and 2a-2 show basic event importance for NMP1, sorted by Fussell-Vesely (FV) importance for each basic event with a FV greater than 0.01. Table 2a-1 shows a sorting for Level 1 (i.e., CDF), and Table 2a-2 shows a sorting for Level 2 (i.e., LERF). Similarly, Tables 2a-3 and 2a-4 provide basic event importance by FV for both CDF and LERF, respectively, for NMP2. These tables were derived based on the full unit-specific PRA model quantification. This included internal events and fire and seismic initiators for both units.

Table 2a-1
NMP1 CDF Importance List Review

Event Name	FV	Description	SAMA Discussion
HRA_OPER___ZHRA1	2.1E-01	Control room fire fails AC, operators initially in control room. Operator fails to use East/ West Instrument Rooms.	SAMAs 209, 215
PMP_100_02_PFZRD	1.8E-01	PMP-100-02 fails to run, Diesel Fire Pump	SAMA 154. NMP1 has the capability to cross-tie fire system with the NMP2 Fire System. This has not yet been credited in the PRA.
AA_OPERSHEDZAA01	1.5E-01	Operators fail to shed load prior to 16/7A to 16/7B cross-tie	SAMA 220
NSL________ZZNSL	1.4E-01	Probability of a Reactor Recirc Pump Seal LOCA given no cooling	NMP1 has installed improved Recirc Pump Seals and no further improvement have been identified. However, SAMA 4 is directed at reducing seal challenges.
RECOGR1HORZZOGR1	8.5E-02	Failure of offsite power recovery in 1 hour	This is a data-based variable in the PRA. SAMA 211 addresses DC initiated cases and SAMA 215 (portable charger) would provide additional time for AC Recovery.
OD_OPER____ZOD01	5.6E-02	Operators fail to emergency depressurize	SAMA 180
FL_OPER_____ZFL01	5.6E-02	Operators fail to prevent RPV overfill	SAMA 180
HRA_OPER___ZHRA4	5.4E-02	In-plant fire fails AC, operators initially in control room. Operator fails to use East/ West Instrument Rooms.	SAMAs 209, 215
FL_________ZZFL3	4.8E-02	RPV Overfill into EC Causing Isolation, given loss of instrument air	SAMA 222

Event Name	FV	Description	SAMA Discussion
FW_OPER____ZFW01	4.5E-02	Operator fails to open 59-07 or 59-08	SAMA 222
CF_OPER____ZCF01	3.9E-02	Operator fails to recognize that injection is required from external sources	SAMA 148
BAT_B11____BBZD1	3.5E-02	BAT-B11 fails on demand	No specific modifications were identified to improve battery reliability directly; however, SAMA 211 and SAMA 209 address sequences where battery failure is significant.
BKR_R113___CAZO1 BKR_R122___CAZO1	3.2E-02	Common cause failure - BKR-(11/3-2)R113/131 fails to open, BKR-(12/1-13)R122/141 fails to open	Sequence failure involves failure of offsite power fast transfer with subsequent failure of operators to manage loads when cross-tying 16A/16B and 17A/17B buses. This is addressed by SAMA 220.
EG_EDG103__GAZR2	3.1E-02	Emergency Diesel Generator (EDG) 103 fails to run after the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 209, 215, 220).
BKR_R112___CAZP1 BKR_R123___CAZP1	3.1E-02	Common cause failure - BKR-R112 fails to close, BKR-R123 fails to close	Sequence failure involves failure of offsite power fast transfer with subsequent failure of operators to manage loads when cross-tying 16A/16B and 17A/17B buses. This is addressed by SAMA 220.
WC_C3W3_MU_CWMU3	3.0E-02	Maintenance of containment spray train.	SAMAs 29, 30
O15_OPER___ZO151	2.8E-02	DC load shedding in 15 minutes fails	SAMAs 180, 215
RECOSP8HORZZOSP8	2.7E-02	Offsite power recovery within 8 hours fails	SAMAs 209, 215

Event Name	FV	Description	SAMA Discussion
PSV_01_102AVDZO1 PSV_01_102BVDZO1 PSV_01_102CVDZO1 PSV_01_102DVDZO1 PSV_01_102EVDZO1 PSV_01_102FVDZO1	2.6E-02	ERVs fail to open on demand - common cause	SAMA 106
EG_EDG102__GAZR2	2.5E-02	EDG 102 fails to run after the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 209, 215, 220).
R3_OPER____ZR101	2.5E-02	Operator fails to align backup uninterruptible power supply (UPS)	SAMA 180. Not credited in the PRA (i.e., set to 0.999).
OG________ZZOG1	2.4E-02	Loss of offsite power (LOSP) given that LOSP is not the initiator.	No SAMAs were identified to directly reduce offsite AC failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve LOSP (i.e., SAMAs 209, 215, 220).
QM________ZZZ30	2.4E-02	Reactor SCRAM failure – mechanical	No SAMAs were identified to directly reduce SCRAM failure probability; however, SAMA 113 deals with reducing sequence probability for those sequences that involve ATWS.
RECOSP2HORZZOSP2	2.3E-02	Offsite power recovery within 2 hours fails	SAMAs 209, 215
BAT_B11____BBZD1 BAT_B12____BBZD1	2.3E-02	Common cause failure of batteries on demand	No specific modifications were identified to improve battery reliability directly; but SAMA 211 and SAMA 209 address sequences where battery failure is significant.

Event Name	FV	Description	SAMA Discussion
RECEDG28HRZZEDG8	2.2E-02	EDG recovery within 8 hours fails	No specific modifications were identified to improve EDG recovery success rate directly, but SAMA 209 and SAMA 215 address sequences where EDG failure is significant.
OH________ZZZ17	2.1E-02	Containment Spray System fails (2 trains available)	SAMAs 29, 30
WC_C1W1_MU_CWMU1	2.0E-02	Maintenance of containment spray train	SAMAs 29, 30
RECEDG22HRZZEDG2	2.0E-02	EDG recovery within 2 hours fails	No specific modifications were identified to improve EDG recovery success rate directly, but SAMA 209 and SAMA 215 address sequences where EDG failure is significant.
OR_OPER____ZOR14	1.8E-02	Operator fails to align fire water (SBO >2 hours)	SAMA 180
OR_OPER____ZOR12	1.7E-02	Operator fails to align fire water	SAMA 180
HRA_OPER___ZHRA9	1.6E-02	Loss of instrument buses. Operator fails to use East/ West Instrument Rooms.	SAMA 209
B3_OPER____ZB101	1.6E-02	Operator fails to recover fast transfer	SAMA 180
OH________ZZZ18	1.5E-02	Containment Spray System fails (1 train available)	SAMAs 29, 30
UPS_UPS162AEUZDD UPS_UPS162BEUZDD UPS_UPS172AEUZDD UPS_UPS172BEUZDD	1.5E-02	Common cause failure of RPS UPSs	No specific modifications were identified to improve UPS reliability, but SAMA 209 addresses sequences where RPS UPS failure is significant.

Event Name	FV	Description	SAMA Discussion
RECEDG18HRZZEDGD	1.5E-02	Recovery of 1 of 1 EDGs in 8 hours	No specific modifications were identified to improve EDG recovery success rate directly, but SAMA 209 and SAMA 215 address sequences where EDG failure is significant.
[EG_EDG103__GAZS1]	1.4E-02	EDG 103 fails to start on demand	No specific modifications were identified to improve EDG recovery success rate directly, but SAMA 209 and SAMA 215 address sequences where EDG failure is significant.
LS_OPER____ZLS02	1.4E-02	Operators fail shed diesel loads given loss of both 115kV sources	SAMAs 180, 220. Also, SAMA 209 and SAMA 215 address sequences where EDG failure is significant.
RECEDG21HRZZEDG1	1.4E-02	Recovery of 1 of 2 EDGs in 1 hours	No specific modifications were identified to improve EDG recovery success rate directly, but SAMA 209 and SAMA 215 address sequences where EDG failure is significant.
B1_FAST____ZZB31	1.3E-02	PB11 fast transfer failure during plant trip	Sequence failure involves failure of offsite power fast transfer with subsequent failure of operators to manage loads when cross-tying 16A/16B and 17A/17B buses. This is addressed by SAMA 220.
PSV_01_102AVDZP1	1.3E-02	ERV PSV-01-102A fails to close	SAMA 110
PSV_01_102DVDZP1	1.3E-02	ERV PSV-01-102D fails to close	SAMA 110
PSV_01_102EVDZP1	1.3E-02	ERV PSV-01-102E fails to close	SAMA 110
PSV_01_102BVDZP1	1.3E-02	ERV PSV-01-102B fails to close	SAMA 110
PSV_01_102FVDZP1	1.3E-02	ERV PSV-01-102F fails to close	SAMA 110
PSV_01_102CVDZP1	1.3E-02	ERV PSV-01-102C fails to close	SAMA 110

Event Name	FV	Description	SAMA Discussion
EG_EDG102__GAZR2 EG_EDG103__GAZR2	1.2E-02	Common cause EDG failure to run after the first hour	No specific modifications were identified to improve EDG recovery success rate directly, but SAMA 209 and SAMA 215 address sequences where EDG failure is significant.
CI________ZZZ22	1.2E-02	Injection failure during containment failure	SAMA 64 addresses improved containment venting which reduces containment failure challenges. SAMA 180 addresses operator reliability which contributes significantly to loss of Decay Heat Removal (DHR) and containment venting failure.
EG_EDG102__GAZS1	1.2E-02	EDG 102 fails to start on demand	No specific modifications were identified to improve EDG recovery success rate directly, but SAMA 209 and SAMA 215 address sequences where EDG failure is significant.
PMP_72_04__PCZRD	1.1E-02	Service Water PMP-72-04 fails to run	SAMAs 4, 21,112, 212
NPRP______ZNPRP1	1.1E-02	Fire propagation in Aux Control Room (not suppressed)	No modifications for reducing aux control room fire propagation were identified. Fire pump failure contributes significantly in these scenarios and NMP1 has the capability to cross-tie its fire system with the NMP2 Fire System. This has not yet been credited in the PRA. Seal LOCA also contributes and NMP1 has already installed improved recirc pump seals.

Event Name	FV	Description	SAMA Discussion
MCR_OPER___ZMCR1	1.1E-02	Operator fails to remain in Control Room (CR) during CR fire	No modifications for increasing the likelihood of continued control room habitability given a control room fire were identified. Fire pump failure contributes significantly in these scenarios and NMP1 has the capability to cross-tie its fire system with the NMP2 Fire System. This has not yet been credited in the PRA. Seal LOCA also contributes and NMP1 has already installed improved recirc pump seals. Operator actions external to the control room, which also contribute, are addressed by SAMA 209.
OH________ZZZ16	1.0E-02	Containment Spray System fails (3 trains available)	SAMAs 29, 30

Table 2a-2
NMP1 LERF Importance List Review

Event Name	FV	Description	SAMA Discussion
QM________ZZZ30	1.4E-01	Reactor SCRAM failure – mechanical	No SAMAs were identified to directly reduce SCRAM failure probability; however, SAMA 113 deals with reducing sequence probability for those sequences that involve ATWS.
BAT_B11____BBZD1 BAT_B12____BBZD1	1.3E-01	Common cause failure of batteries on demand	No specific modifications were identified to improve battery reliability directly, but SAMA 211 and SAMA 209 address sequences where battery failure is significant.
AA_OPERSHEDZAA01	1.2E-01	Operators fail to shed load prior to 16/7A to 16/7B cross-tie	SAMA 220
PSV_01_102AVDZO1 PSV_01_102BVDZO1 PSV_01_102CVDZO1 PSV_01_102DVDZO1 PSV_01_102EVDZO1 PSV_01_102FVDZO1	1.2E-01	ERVs fail to open on demand - common cause	SAMA 106
NSL_______ZZNSL	9.2E-02	Probability of a Reactor Recirc Pump Seal LOCA given no cooling	NMP1 has installed improved Recirc Seals and no further improvement have been identified. However, SAMA 4 is directed at reducing seal challenges.
FL_OPER____ZFL01	7.4E-02	Operators fail to prevent RPV overfill	SAMA 180
FL________ZZFL3	6.9E-02	RPV overfill into EC causing isolation, given loss of instrument air	SAMA 222

Event Name	FV	Description	SAMA Discussion
FW_OPER____ZFW01	6.7E-02	Operator fails to open 59-07 or 59-08	SAMA 222
RECOGR1HORZZOGR1	5.5E-02	Failure of offsite power recovery in 1 hour	This is a data-based variable in the PRA. SAMA 211 addresses DC initiated cases and SAMA 215 (portable charger) would provide additional time for AC recovery.
PMP_100_02_PFZRD	4.8E-02	PMP-100-02 fails to run, Diesel Fire Pump	SAMA 154. NMP1 has the capability to cross-tie its fire system with the NMP2 Fire System. This has not yet been credited in the PRA.
OD_OPER____ZOD01	3.8E-02	Operators fail to emergency depressurize	SAMA 180
RECOSP2HORZZOSP2	3.5E-02	Offsite power recovery within 2 hours fails	SAMAs 209, 215
BAT_B11____BBZD1	3.1E-02	BAT-B11 fails on demand	No specific modifications were identified to improve battery reliability directly, but SAMA 211 and SAMA 209 address sequences where battery failure is significant.
WC_C3W3_MU_CWMU3	2.7E-02	Maintenance of containment spray train.	SAMA 29, 30
RECEDG22HRZZEDG2	2.5E-02	EDG recovery within 2 hours fails	No specific modifications were identified to improve EDG recovery success rate directly, but SAMA 209 and SAMA 215 address sequences where EDG failure is significant.
OG________ZZOG1	2.4E-02	Loss of offsite power given LOSP is not the initiator.	No SAMAs were identified to directly reduce offsite AC failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve LOSP (i.e., SAMAs 209, 215, 220)
O15_OPER___ZO151	2.4E-02	DC Load shedding in 15 minutes fails	SAMAs 180, 215

Event Name	FV	Description	SAMA Discussion
CH_OPER____ZCH02	2.2E-02	Operator fails to terminate and prevent injection with feedwater	SAMA 180
MO_OPER____ZMO01	2.1E-02	Operator fails to disable MSIV isolation signal (ATWS)	SAMA 180
EP_OPER____ZEP02	2.0E-02	Operator fails to align liquid poison early (CN=S*UL=F)	SAMA 180
UL_OPER____ZUL01	2.0E-02	Operators fail to initiate level/power control, Main Condenser initially available	SAMA 180
BAT_B12____BBZD1	1.9E-02	BAT-B12 fails on demand	No specific modifications were identified to improve battery reliability directly, but SAMA 211 and SAMA 209 address sequences where battery failure is significant.
WC_C1W1_MU_CWMU1	1.7E-02	Maintenance of containment spray train.	SAMAs 29, 30
EG_EDG103__GAZR2	1.6E-02	EDG 103 fails to run after the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 209, 215, 220).
AI_OPER____ZAI02	1.5E-02	Operators inhibit ADS given ATWS and loss of Feedwater initiator	SAMA 180
LS_OPER____ZLS02	1.4E-02	Operators fail to load shed diesel loads given loss of both 115 kV sources	SAMA 180, 220. Also, SAMA 209 and SAMA 215 address sequences where EDG failure is significant.
EG_EDG102__GAZR2	1.3E-02	EDG 102 fails to run after the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 209, 215, 220).

Event Name	FV	Description	SAMA Discussion
HRA_OPER___ZHRA4	1.3E-02	In-plant fire fails AC, operators initially in control room. Operator fails to use East/ West Instrument Rooms.	SAMAs 209, 215
RECEDG21HRZZEDG1	1.1E-02	Recovery of 1 of 2 EDGs in 1 hour	No specific modifications were identified to improve EDG recovery success rate directly, but SAMA 209 and SAMA 215 address sequences where EDG failure is significant.
HE_________ZZHE1	1.1E-02	Environmental impact fails injection given interfacing system LOCA (ISLOCA) leakage	No improvements were identified for ISLOCA frequency reduction or ISLOCA mitigation effectiveness.
BKR_11_52__CAZO1	1.0E-02	BKR-(11/3-11)52 fails to open (Feedwater Pump 11)	No improvements were identified for feedwater pump trip in ATWS scenarios. This modeling is considered conservative, and is noted as such in the PRA, since overfill does not necessarily result in enough over-power to fail the RPV. Also, circuit breaker failure could be mitigated by other actions such as closing valves.
BKR_12_52__CAZO1	1.0E-02	BKR-(11/3-11)52 fails to open (Feedwater Pump 11)	No improvements were identified for feedwater pump trip in ATWS scenarios. This modeling is considered conservative, and is noted as such in the PRA, since overfill does not necessarily result in enough over-power to fail the RPV. Also, circuit breaker failure could be mitigated by other actions such as closing valves.
OR_OPER____ZOR14	1.0E-02	Operator fails to align fire water (SBO >2 hours)	SAMA 180

Table 2a-3
NMP2 CDF Importance List Review

Event Name	FV	Description	SAMA Discussion
OSPZZZOFFINP5H01	6.04E-01	Offsite power recovery within 30 minutes	Offsite power recovery within 30 minutes is driven by reactor core isolation cooling (RCIC) failure. SAMA 216 would provide redundant capability via DFP.
RECZZZEG12P5HE30	4.70E-01	failure to recover 1 of 2 EDGs in 0.5 hours	Offsite power recovery within 30 minutes is driven by RCIC failure. SAMA 216 would provide redundant capability via DFP.
CSHZHSD3EDGSBO01	4.59E-01	Operator fails to align (Div III) EDG2 to alternate division given SBO (RCIC failed)	SAMA 218
HVPHCZXUC1AXXXL5	2.42E-01	2HVP*UC1A Div I / EDG1 Room Unit Cooler fails	SAMA 221
HVPHCZXUC1BXXXLC	1.48E-01	2HVP*UC1B Div II / EDG2 Room Unit Cooler fails	SAMA 221
MSSZODMSSOP1OO01	9.76E-02	Operators fail to initiate ADS	SAMA 150
ICSPT1XP1XXXXXRD	9.49E-02	RCIC Pump fails to run	SAMA 216 would provide redundant capability via DFP.
HVPFFZXUC1BOMXRD	9.15E-02	2HVP*UC1B Div II / EDG2 Room Unit Cooler Fan fails	SAMA 221
EGSGAZXEG3XXXXS1	7.35E-02	2EGS*EG3 Div II Emergency Diesel Generator fails to start on demand	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
ICSPT1XP1XXXXXS2	7.18E-02	RCIC Pump fails to re-start	SAMA 216 would provide redundant capability via DFP.

Event Name	FV	Description	SAMA Discussion
ICSPT1XP1XXXXXS3	7.18E-02	RCIC Pump fails to re-start second time	SAMA 216 would provide redundant capability via DFP.
ICSPT1XP1XXXXXS1	7.18E-02	RCIC Pump fails to start	SAMA 216 would provide redundant capability via DFP.
EGSGAZXEG3XXXXR2	6.31E-02	2EGS*EG3 Div II Emergency Diesel Generator fails to run after the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
HVPFFZXUC1AOMXRD	5.97E-02	2HVP*UC1A Div I / EDG1 Room Unit Cooler Fan fails	SAMA 221
CFXZZZXLLDFAIL51	5.44E-02	Large lower drywell or wetwell failure	This is a containment failure that causes core damage related to loss of decay heat removal. There are no specific SAMA for directly strengthening primary containment for this failure mode. However, the relevant sequences are addressed by SAMAs 21, 213, 219).
EGSGAZXEG1XXXXS1	4.80E-02	2EGS*EG1 Div I Emergency Diesel Generator fails to start on demand	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
RECZZZEG11P5HD30	4.41E-02	Failure to recover 1 of 1 EDGs in 0.5 hours	Offsite power recovery within 30 minutes is driven by RCIC failure. SAMA 216 would provide redundant capability via DFP.
ICSPT1XP1XXXXXR2	4.39E-02	2ICS*P1 RCIC Turbine-Driven Pump fails to run (t=0-2 hrs)	SAMA 216 would provide redundant capability via DFP.

Event Name	FV	Description	SAMA Discussion
EGSGAZXEG1XXXXR2	4.11E-02	2EGS*EG1 Div I Emergency Diesel Generator fails to run after the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
ZZZZZZTEMP78XHOT	3.96E-02	Ambient temp >78 °F	When temperature is greater than 78°F, EDG room coolers are no longer considered redundant and single room vent fans can cause EDG failure. No SAMAs were identified to directly reduce EDG room vent failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
EGSGAZXEG3XXXXR1	3.43E-02	2EGS*EG3 Div II EDG fails to run during the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
EGSGBZXEG2XXXXR2	3.26E-02	High Pressure Core Spray (HPCS) EDG fails to run after the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
ICSVC1XV27XXXXO1	3.04E-02	RCIC check valve 2ICS*V27 fails to open	SAMA 216 would provide redundant capability via DFP.
ICSVC1XV249XXXO1	3.04E-02	RCIC check valve 2ICS*V249 fails to open	SAMA 216 would provide redundant capability via DFP.
ICSVC1XAOV157XO1	2.90E-02	RCIC AOV 2ICS*AOV157 fails to open	SAMA 216 would provide redundant capability via DFP.
ICSVC1XAOV156XO1	2.90E-02	RCIC check valve 2ICS*AOV156 fails to open	SAMA 216 would provide redundant capability via DFP.

Event Name	FV	Description	SAMA Discussion
BYSBBZXBAT2BXXD1	2.67E-02	Battery 2B fails on demand	SAMAs 57, 58
CPSZCVXXXXXXXX02	2.64E-02	Operators fail to align containment venting when air or Div I AC is unavailable	SAMAs 215, 219
OSPZZZLOSPRECXO8	2.63E-02	Failure to recover AC power in 8 hours	Addressed by SAMA 215.
RECZZZEGR1208HE8	2.61E-02	Failure to recover 1 of 2 EDGs in 8 hours	Addressed by SAMA 215.
RECZZZE11018HD18	2.57E-02	Failure to recover 1 of 1 EDGs in 18 hours	This involves EDG recovery for support of non-SBO LOSP events that lead to loss of DHR. Addressed by SAMAs 21, 23, 24, 213.
HVPHCZXUC2XXXXLC	2.56E-02	HPCS EDG Unit Cooler fails	SAMA 221
HVPVDMXMOD1CXXO1 HVPVDMXMOD1DXXO1 HVPVDMXMOD6CXXO1 HVPVDMXMOD6AXXO1 HVPVDMXMOD1AXXO1 HVPVDMXMOD6DXXO1 HVPVDMXMOD1BXXO1 HVPVDMXMOD6BXXO1	2.28E-02	Common-cause failure of EDG building HVAC dampers to open on demand.	No SAMAs were identified to directly reduce EDG room vent failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
EGSGAZXEG1XXXXR1	2.24E-02	2EGS*EG1 Div I Emergency Diesel Generator fails to run during the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
ENSCA2SWG10314P1	2.20E-02	EDG 3 output breaker fails to close	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).

Event Name	FV	Description	SAMA Discussion
OSPZZZLOSPRECO18	2.05E-02	Failure to recover AC power in 18 hours	This involves EDG recovery for support of non-SBO LOSP events that lead to loss of decay heat removal (DHR). Addressed by SAMAs 21, 23, 24, 213.
IERZIEKABXRECV02	2.04E-02	Operator fails to prevent plant trip given partial LOSP.	Operators have demonstrated this capability during a number of partial LOSP events. No SAMA could be identified to directly address this postulated event; however, several SAMAs deal with reducing sequence probability for those sequences that involve loss of AC power (i.e., SAMAs 56, 215, 216, 218).
ICSZICHHLEVEL802	1.92E-02	Operator fails to prevent RCIC trip on level 8	SAMA 216 would provide capability redundant to RCIC via the Diesel Fire Pump (DFP).
RPSZZZXXQMXXXX42	1.91E-02	Mechanical SCRAM failure	No SAMAs were identified to directly reduce SCRAM failure probability; however, SAMA 113 deals with reducing sequence probability for those sequences that involve ATWS.
ENSZKROPERSWAP01	1.90E-02	Operator fails alternate emergency AC alignment via Aux Boiler Transformer	SAMA 180, 214. Also, several SAMAs deal with reducing sequence probability for those sequences that involve loss of AC power (i.e., SAMAs 56, 215, 216, 218).
ICSZMEECCSACTX01	1.89E-02	Operator fails to manually start emergency core cooling systems (ECCS)	SAMA 180
EGSGAZXEG1XXXXS1 EGSGAZXEG3XXXXS1	1.89E-02	Common-cause EDG failure (to start)	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).

Event Name	FV	Description	SAMA Discussion
ENSCA2XSWG1034O1	1.83E-02	Normal supply breaker to SWG003 fails to open given LOSP	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
ICSHCZXE1XXXXXLQ	1.82E-02	RCIC Lube Oil Cooler fails	SAMA 216 would provide capability redundant to RCIC via DFP.
HVRHCZXUC403AXL5	1.82E-02	HPCS Room Cooler A fails	SAMAs 23, 24
EGSGAZXEG1XXXXR2 EGSGAZXEG3XXXXR2	1.71E-02	Common-cause EDG failure (to start)	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218)
HVRHCZXUC403BXL5	1.68E-02	HPCS Room Cooler B fails	SAMAs 23, 24
HVPFFZXUC2OMXXRD	1.58E-02	HPCS EDG Room Cooler fan fails to run	SAMA 221
BYSBBZXBAT2AXXD1	1.51E-02	Battery 2A fails on demand	SAMAs 57, 58
CFXZZZXLUDFAIL47	1.50E-02	Large upper drywell failure	This is a containment failure that causes core damage related to loss of decay heat removal. There are no specific SAMAs for directly strengthening primary containment for this failure mode. However, the relevant sequences are addressed by SAMAs 21, 213, 219.
CFXZZZHSFAILBX54	1.50E-02	HPCS fails due to large containment failure	This is a failure of HPCS caused by containment failure on over-pressure. There are no specific SAMA for directly strengthening HPCS for this failure mode. However, the relevant sequences are addressed by SAMAs 21, 213, 219.

Event Name	FV	Description	SAMA Discussion
IERZIECBFLOODX01	1.49E-02	Operator fails to mitigate control building flooding	SAMA 223
RHSVC1XV1XXXXXO1	1.45E-02	Residual Heat Removal (RHR) A pump discharge valve fails to open	There are no specific SAMA for directly improving check valve reliability; however, sequences with failure of RHR in low pressure coolant injection (LPCI) mode or in decay heat removal (DHR) modes are addressed by SAMAs 216, 219, 222.
ENSCA2XSWG1011P1	1.44E-02	EDG 1 output breaker fails to close	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
HRAZHRBOPSRICF03	1.40E-02	Operator response to control room fire with RCIC failed.	SAMA 180 deals with improved operator training.
NPSCA3SWG003O1P1	1.37E-02	2NPS-SWG003-1 SWG003 supply breaker from 115-13.8 kV Transformer 2RTX-XSR1 fails open.	This is a failure of the 115 kV supply to non-safety Division of AC power. No SAMAs were identified to directly reduce circuit breaker failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve AC failure (i.e., SAMA 56, 215, 216, 218). Also, to the extent that this failure affects feedwater, SAMAs 180 and 216 are applicable.
ZZZZZZPORTCHGRPC	1.36E-02	Portable charger (not yet installed)	SAMA 215
CPSZCVOPERATOR04	1.33E-02	Operators fail to vent during an SBO (not yet installed)	SAMA 215
EGSGBZXEG2XXXXS1	1.29E-02	HPCS EDG fails to start	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).

Event Name	FV	Description	SAMA Discussion
RECZZZLAKEINTKR8	1.25E-02	Failure to recover loss of instrument air	SAMA 222
CSHVC1XV59XXXXO1	1.22E-02	2CSH*V59 HPCS suction check valve from CST fails to open on demand	SAMA 153
CSHVC1XV9XXXXXO1	1.22E-02	High Pressure Core Spray check valve 2CSH*V9 fails to open	SAMA 153
CSHVC1XV7XXXXXO1	1.22E-02	High Pressure Core Spray check valve 2CSH*V7 fails to open	SAMA 153
CSHVC1XAOV108XO1	1.22E-02	High Pressure Core Spray AOV 2CSH*AOV108 fails to open	SAMA 153
HVRHCZXUC401AXL5	1.19E-02	RHRA Room Cooler A fails	SAMAs 23, 24
HVRHCZXUC401DXL5	1.19E-02	RHRA Room Cooler D fails	SAMAs 23, 24
ENSCA2SWG10113O1	1.19E-02	Normal supply breaker to SWG001 fails to open given LOSP	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
ICSZICHBYPTEMP01	1.10E-02	Operator fails to bypass RCIC trip on high area temperature	SAMA 180
RHSRAZK114AA32LC	1.05E-02	K114A-2RHSA32 (E12A-K114A) LPCI A injection MOV closed permissive relay drops out	Failure of low pressure permissive for LPCI. No specific SAMAs were identified for increasing reliability of injection valves opening on low pressure permissive; however, SAMA 216 addresses hard-pipe DFP injection as a redundant capability including manually opening injection valves.

Event Name	FV	Description	SAMA Discussion
ENSCA2SWG10314P1 ENSCA2XSWG1011P1	1.01E-02	Common cause failure of emergency bus circuit breakers given LOSP	No SAMAs were identified to directly reduce EDG/emergency bus circuit breaker failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
HVPVDMXMOD6BXXO1	1.01E-02	2HVP*MOD6B Div I / EDG1 Diesel Building Motor Oper Recirc Damper	No SAMAs were identified to directly reduce EDG room vent failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
HVPVDMXMOD1DXXO1	1.01E-02	2HVP*MOD1D Div I / EDG1 Diesel Building Motor Oper Recirc Damper	No SAMAs were identified to directly reduce EDG room vent failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).

Table 2a-4
NMP2 LERF Importance List Review

Event Name	FV	Description	SAMA Discussion
OSPZZZOFFINP5H01	2.73E-01	Offsite power recovery within 30 minutes	Offsite power recovery within 30 minutes is driven by RCIC failure. SAMA 216 would provide redundant capability via DFP.
DERZISXXXXXXXX01	2.65E-01	Operators fail to isolate containment locally	SAMA 180 addresses insights for operator training. Also addressed by SAMAs 56, 218.
RECZZZEG12P5HE30	2.64E-01	Failure to recover 1 of 2 EDGs in 0.5 hours	Offsite power recovery within 30 minutes is driven by RCIC failure. SAMA 216 would provide redundant capability via DFP.
CSHZHSD3EDGSBO01	2.57E-01	Operator fails to align (Div III) EDG2 to alternate division given SBO (RCIC failed)	SAMA 218
HVPHCZXUC1AXXXL5	1.66E-01	2HVP*UC1A Div I / EDG1 Room Unit Cooler fails	SAMA 221
MSSZODMSSOP1OO01	1.46E-01	Operator fails to initiate ADS	SAMA 150
RPSZZZXXQMXXXX42	1.42E-01	Mechanical SCRAM failure	No SAMAs were identified to directly reduce SCRAM failure probability; however, SAMA 113 deals with reducing sequence probability for those sequences that involve ATWS.
ICSPT1XP1XXXXXRD	1.17E-01	RCIC Pump fails to run	SAMA 216 would provide redundant capability via DFP.
HVPHCZXUC1BXXXLC	9.0E-02	2HVP*UC1B Div II / EDG2 Room Unit Cooler fails	SAMA 221
IERZIECBFLOODX01	8.4E-02	Operator fails to mitigate control building flooding	SAMA 223
HVPFFZXUC1BOMXRD	5.6E-02	2HVP*UC1B Div II / EDG2 Room Unit Cooler Fan fails	SAMA 221

Event Name	FV	Description	SAMA Discussion
ICSPT1XP1XXXXXS1	5.2E-02	RCIC Pump fails to start	SAMA 216 would provide redundant capability via DFP.
ICSPT1XP1XXXXXS2	5.2E-02	RCIC Pump fails to re-start	SAMA 216 would provide redundant capability via DFP.
ICSPT1XP1XXXXXS3	5.2E-02	RCIC Pump fails to re-start second time	SAMA 216 would provide redundant capability via DFP.
EGSGAZXEG3XXXXS1	4.5E-02	2EGS*EG3 Div II Emergency Diesel Generator fails to start on demand	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
HVPFFZXUC1AOMXRD	4.1E-02	2HVP*UC1A Div I / EDG1 Room Unit Cooler Fan fails	SAMA 221
ZZZZZZPORTCHGRPC	3.9E-02	Portable charger (not yet installed)	SAMA 215
EGSGAZXEG3XXXXR2	3.8E-02	2EGS*EG3 Div II Emergency Diesel Generator fails to run after the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
RECZZZEG1202XHE2	3.5E-02	Failure to recover 1 of 2 EDGs in 2 hours	This is driven by the failure to shed DC loads. SAMA 180 addresses operator training insights.
FWSZFWXXXXXXXX01	3.4E-02	Operator fails to establish feedwater during ATWS	SAMA 180 addresses operator training insights. Also addressed by SAMA 215.
EGSGAZXEG1XXXXS1	3.3E-02	2EGS*EG1 Div I Emergency Diesel Generator fails to start on demand	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
OSPZZZLOSPRECXO2	3.2E-02	Failure to recover offsite power in 2 hours	This is driven by the failure to shed DC loads. SAMA 180 addresses operator training insights. Also, SAMA 215 addresses this.
RPSZCHXXXXXXXX02	3.2E-02	Operator fails to control level in ATWS (OE=F)	SAMA 180 addresses operator training insights.

Event Name	FV	Description	SAMA Discussion
FPWZZZFLOWXXXX27	3.1E-02	Firewater flow to RPV inadequate	SAMA 216
EGSGAZXEG1XXXXR2	2.8E-02	2EGS*EG1 Div I Emergency Diesel Generator fails to run after the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
RECZZZEG11P5HD30	2.8E-02	Failure to recover 1 of 1 EDGs in 0.5 hours	Offsite power recovery within 30 minutes is driven by RCIC failure. SAMA 216 would provide redundant capability via DFP.
ICSPT1XP1XXXXXR3	2.8E-02	RCIC turbine fails to run (t=2 to 8 hours)	SAMA 216 would provide redundant capability via DFP.
ICSPT1XP1XXXXXR2	2.7E-02	RCIC turbine fails to run (t=0 to 2 hours)	SAMA 216 would provide redundant capability via DFP.
ZZZZZZTEMP78XHOT	2.6E-02	Ambient temp >78°F	When temperature is greater than 78°F, EDG room coolers are no longer considered redundant and single room vent fans can cause EDG failure. No SAMAs were identified to directly reduce EDG room vent failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
ISCZZZXSLEAKXX40	2.6E-02	Small pre-existing primary containment leak	Primary containment is normally inerted and significant leaks would be identified. No simple improvements have been identified to make the containment structure more reliable relative to this failure mode.
EGSGBZXEG2XXXXR2	2.5E-02	HPCS EDG fails to run after the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
RPSZCHXXXXXXXX01	2.3E-02	Operator fails to control level in ATWS	SAMA 180 addresses operator training insights.
HVRHCZXUC403BXL5	2.2E-02	HPCS Room Cooler B fails	SAMAs 23, 24
ICSVC1XV249XXXO1	2.2E-02	RCIC check valve 2ICS*V249 fails to open	SAMA 216 would provide redundant capability via DFP.

Event Name	FV	Description	SAMA Discussion
ICSVC1XV27XXXXO1	2.2E-02	RCIC check valve 2ICS*V27 fails to open	SAMA 216 would provide redundant capability via DFP.
HVRHCZXUC403AXL5	2.1E-02	HPCS Room Cooler A fails	SAMAs 23, 24
ICSVC1XAOV156XO1	2.1E-02	RCIC check valve 2ICS*AOV156 fails to open	SAMA 216 would provide redundant capability via DFP.
ICSVC1XAOV157XO1	2.1E-02	RCIC AOV 2ICS*AOV157 fails to open	SAMA 216 would provide redundant capability via DFP.
EGSGAZXEG3XXXXR1	2.1E-02	2EGS*EG3 Div II Emergency Diesel Generator fails to run during the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
MSSVP1XPSV121XO1 MSSVP1XPSV126XO1 MSSVP1XPSV127XO1 MSSVP1XPSV129XO1 MSSVP1XPSV130XO1 MSSVP1XPSV134XO1 MSSVP1XPSV137XO1	2.0E-02	Common-cause failure of SRVs to open on demand	SAMA 106
HVPHCZXUC2XXXXLC	2.0E-02	HPCS EDG unit cooler fails	SAMA 221
CSHVC1XV59XXXXO1	1.6E-02	2CSH*V59 HPCS suction check valve from CST fails to open on demand	SAMA 153
CSHVC1XV7XXXXXO1	1.6E-02	HPCS check valve 2CSH*V7 fails to open	SAMA 153
CSHVC1XV9XXXXXO1	1.6E-02	HPCS check valve 2CSH*V9 fails to open	SAMA 153
CSHVC1XAOV108XO1	1.6E-02	HPCS AOV 2CSH*AOV108 fails to open	SAMA 153
EGSGAZXEG1XXXXR1	1.5E-02	2EGS*EG1 Div I Emergency Diesel Generator fails to run during the first hour	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).

Event Name	FV	Description	SAMA Discussion
HVPVDMXMOD1AXXO1 HVPVDMXMOD1BXXO1 HVPVDMXMOD1CXXO1 HVPVDMXMOD1DXXO1 HVPVDMXMOD6AXXO1 HVPVDMXMOD6BXXO1 HVPVDMXMOD6CXXO1 HVPVDMXMOD6DXXO1	1.5E-02	Common-cause failure of EDG building HVAC dampers to open on demand.	No SAMAs were identified to directly reduce EDG room vent failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
ICSZMEECCSACTX01	1.5E-02	Operator fail to manually start ECCS	SAMA 180
ENSCA2SWG10314P1	1.3E-02	EDG 3 output breaker fails to close	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
ICSHCZXE1XXXXXLQ	1.3E-02	RCIC lube oil cooler fails	SAMA 216 would provide capability redundant to RCIC via DFP.
BYSBBZXBAT2BXXD1	1.3E-02	Battery 2B fails on demand	SAMAs 57, 58
ICSZICHHLEVEL802	1.3E-02	Operator fails to prevent RCIC trip on level 8 (high RPV level)	SAMA 216 would provide capability redundant to RCIC via DFP.
EGSGAZXEG1XXXXS1 EGSGAZXEG3XXXXS1	1.3E-02	Common-cause EDG failure (to start)	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
HVPFFZXUC2OMXXRD	1.2E-02	HPCS EDG Room Cooler Fan fails to run	SAMA 221

Event Name	FV	Description	SAMA Discussion
ISCVC3XRV33AXXO1 ISCVC3XRV33BXXO1 ISCVC3XRV34AXXO1 ISCVC3XRV34BXXO1 ISCVC3XRV35AXXO1 ISCVC3XRV35BXXO1 ISCVC3XRV36AXXO1 ISCVC3XRV36BXXO1	1.2E-02	Containment vacuum breakers fail to open to equalize pressure – common-cause	SAMA 161
EGSGAZXEG1XXXXR2 EGSGAZXEG3XXXXR2	1.1E-02	Common-cause EDG failure (to run after the first hour)	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
ENSCA2XSWG1034O1	1.1E-02	Normal supply breaker to SWG003 fails to open given LOSP	No SAMAs were identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
BYSBBZXBAT2AXXD1	1.0E-02	Battery 2A fails on demand	SAMAs 57, 58
EGSGBZXEG2XXXXS1	1.0E-02	HPCS EDG fails to start	No SAMAs identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).
ENSCA2XSWG1011P1	1.0E-02	EDG 1 output breaker fails to close	No SAMAs identified to directly reduce EDG failure probability; however, several SAMAs deal with reducing sequence probability for those sequences that involve EDG failure (i.e., SAMAs 56, 215, 216, 218).

b. *Section F.1.5.2 indicates that containment isolation during station blackout (SBO) has the highest rank LERF RRW (for Unit 2), yet it does not appear to be addressed by a SAMA. Please clarify and/or justify.*

Response 2b

Improved containment isolation has been considered in the past at NMP. However, setting containment isolation reliability to perfect (guaranteed success) has a minor benefit for the following reasons:

- There is no reduction in core damage frequency.
- Although containment isolation is a contributor to LERF (approximately 30 percent contributor), the frequency of LERF is low relative to other releases such that the contribution to maximum benefit from LERF is relatively low (less than $300K). The 30 percent contribution from containment isolation results in a maximum benefit of less than $100K. The actual benefit was calculated and found to be approximately $60K.

Replacing motor-operated valves with air-operated, fail-closed valves, for example, is judged to cost much more than this potential benefit. NMPNS has observed during the SAMA evaluations that focusing on LERF alone is not sufficient to obtain large benefits. There is a need to reduce the frequency of other or all major releases, such as reducing core damage frequency.

c. *Since large early releases account for only about 10% of the total offsite population dose, the review of sequences that are important to LERF (described in Section 4.16.3 of the ER) could have overlooked SAMAs that are important to population dose. Address whether any additional candidate SAMAs would be identified if the SAMA identification process considered sequences important to population dose rather than LERF. Provide a further evaluation of any such SAMAs.*

Response 2c

In the process to identify candidate SAMAs, NMPNS focused on all the dominant risk sequences identified by the models, as well as the results of other risk-importance studies, without regard to their contribution to LERF. The SAMA evaluation considered the dominant contributors to CDF, LERF, shutdown risk, and accident sequences which do not contribute to CDF. Notably, LERF represented only a small fraction (8% for NMP1 and 2% for NMP2) of all release end states considered. As a result, SAMAs related to sequences important to population dose other than LERF were considered as part of the screening process.

d. The ER identifies and provides estimated benefit and cost information for only those SAMAs that remained after the initial screening. Also, for most of the plant-specific SAMAs, cost benefit information is provided for only one of the units. Provide the complete list of the plant-specific candidate SAMAs considered for Units 1 and 2, and the cost benefit information for each of these SAMAs for both units, unless a SAMA is not applicable to the other unit.

Response 2d

As noted in LRA ER Section 4.16.1, the designs for the two units are completely different. Because of the major design differences (plant layout, electrical separation, and systems and structural design), the risk profiles are also very different for the two units; therefore, unit-specific SAMA analyses were evaluated for each of the NMP units. However, in the initial stages of the analysis, NMPNS developed a single numbered list of candidate SAMAs for consideration in the unit-specific analyses. The following Table 2d-1 provides the screening results by unit for the SAMAs from the initial list of 207 SAMAs and for each of the plant-specific SAMAs (numbered 208 – 223) that were retained for evaluation.

Table 2d-1
NMP1 and NMP2 Plant-Specific SAMA Screening and Analysis Results

SAMA No.	Potential Enhancement	NMP1 Screening Result and Discussion	NMP2 Screening Result and Discussion
4	Provide Training for Loss of RBCLC	Net benefit of ($21,400). [Using a 3 percent discount rate, the net benefit is ($18,000).]	Screened out because the proposed SAMA is related to RCP seal leakage. A review of NUREG-1560 indicates that although reactor coolant pump (RCP) seal leakage is important to PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs.
21	Firewater Supply to SDC Heat Exchanger	Net benefit of ($459,000). [Using a 3 percent discount rate, the net benefit is ($442,000).]	After further review of this modification, NMPNS determined that no benefit could be achieved; therefore, a detailed evaluation was not performed.
23a	Provide Redundant Ventilation for RHR Pump Rooms	Screened out because it doesn't provide a significant benefit (<1% of CDF).	Positive net benefit of $180,000.
23b	Provide Redundant Ventilation for HPCS Pump Room	Screened out because it doesn't provide a significant benefit (<1% of CDF).	Positive net benefit of $234,000.

SAMA No.	Potential Enhancement	NMP1 Screening Result and Discussion	NMP2 Screening Result and Discussion
23c	Provide Redundant Ventilation for RCIC Pump Room	Screened out because it doesn't provide a significant benefit (<1% of CDF).	Positive net benefit of $47,500.
24	Improve Procedures for Loss of Control Room HVAC	After further review of this modification, NMPNS determined that no benefit could be gained from a procedure change; therefore, a detailed evaluation was not performed.	After further review of this modification, NMPNS determined that no benefit could be gained from a procedure change; therefore, a detailed evaluation was not performed.
56	Additional Diesel for On-site Emergency AC Power	Screened out because it would not provide a significant benefit relative to a cost that is estimated to exceed $2 million dollars.	Net benefit of >($9,040,000). [Using a 3 percent discount rate, the net benefit is >($8,780,000).]
73	Firewater Back-up for EDG Cooling	Screened out because it was already installed.	Net benefit of ($365,000). [Using a 3 percent discount rate, the net benefit is ($316,000).]
112	Modify RWCU for Decay Heat Removal	After further review of this modification, NMPNS determined that no benefit could be gained; therefore, a detailed evaluation was not performed.	After further review of this modification, NMPNS determined that no benefit could be gained; therefore, a detailed evaluation was not performed.
113	Use of CRD for Alternate Boron Injection	Net benefit of >($64,500). [Using a 3 percent discount rate, the net benefit is still negative at >($62,300).]	Net benefit of ($103,000). [Using a 3 percent discount rate, the net benefit is ($86,100).]
208	Improve Drywell Head Bolts	Net benefit of >($148,000). [Using a 3 percent discount rate, the net benefit is still negative at >($148,000).]	Net benefit of ($119,000). [Using a 3 percent discount rate, the net benefit is ($107,000).]
209	Improve SOP-14 and Provide Training	Positive net benefit of $419,000.	Screened out because it was not applicable to the unit design.
210	Protect Critical Fire Targets	Positive net benefit of $419,000.	Screened out because it was already installed.

SAMA No.	Potential Enhancement	NMP1 Screening Result and Discussion	NMP2 Screening Result and Discussion
211	Reduce Offsite Dependency on DC11	Net benefit of ($25,600). [Using a 3 percent discount rate, the net benefit is still negative at ($16,000).]	Screened out because it was already installed.
212	Capability to Manually Operate Containment Venting	Net benefit of >($2,500). [Using a 3 percent discount rate, the net benefit is positive at >$12,400.][a]	Screened out because a similar modification is addressed under proposed SAMA 215.
213	Enhance Loss of Service Water Procedure	Screened out because it was not applicable to the unit design.	Positive net benefit of $234,000.
214	Enhance SBO Procedures	Screened out because it was already installed.	Positive net benefit of >$70,000.
215	Add a Portable Charger	Positive net benefit of $399,000.	Positive net benefit of $457,000. Implementation of U2-216 and/or -221 would reduce the modeled benefit. Implementation of this modification was qualitatively assessed. The estimated benefit is based on engineering judgment from experience in dealing with the assessment of workweek risk when taking an offsite power line out of service.
216	Hard Pipe Diesel Fire Pump to the RPV	Screened out because it was already installed.	Positive net benefit of $600,000. Implementation of U2-215 and/or -221 would reduce the modeled benefit.
218	Improve the HPCS Crosstie to Division I/II	Screened out because it was not applicable to the unit design.	After further evaluation, NMPNS determined this concept was not feasible for implementation to achieve the modeled benefit. Implementation of SAMAs U2-215, -216, and -221 are judged to provide a more reliable and cost-effective alternative.
219	Improve Containment Venting	Screened out because it was not applicable to the unit design.	Net benefit of ($387,000). [Using a 3 percent discount rate, the net benefit is ($272,000).]

SAMA No.	Potential Enhancement	NMP1 Screening Result and Discussion	NMP2 Screening Result and Discussion
220	Installation of New Transformers to Improve AC Power Load Management	Net benefit of ($305,000). [Using a 3 percent discount rate, the benefit changes to a net benefit of ($189,000).]	Screened out because it was not applicable to the unit design.
221a	Reduce Unit Cooler Contribution to EDG Unavailability – increase testing frequency	Screened out because it was not applicable to the unit design.	Positive net benefit of $287,000.
221b	Reduce Unit Cooler Contribution to EDG Unavailability – provide redundant means of cooling	Screened out because it was not applicable to the unit design.	Positive net benefit of $817,000.
222	Improved Response to Loss of Instrument Air	Net benefit of ($512,000). [Using a 3 percent discount rate, the benefit changes to a net benefit of ($478,000).]	Positive net benefit of $243,000.
223	Improve Control Building Flooding Scenarios	Screened out because it was not applicable to the unit design.	Net benefit of ($13,300). [Using a 3 percent discount rate, the net benefit is $18,300.]

Notes

(a) Correction of an editorial error in the initial LRA ER.

e. The process used to screen the initial list of 207 SAMAs is described only briefly in Section 4.16.3. Describe the screening process in more detail, the screening criteria used, and for each criterion, the number of SAMAs eliminated.

Response 2e

As noted in Section 4.16.3 of the LRA ER, NMP Operations, Design, and Risk Assessment personnel reviewed the initial list of SAMAs, numbered 1 through 207, and identified additional site-specific SAMAs (numbered 208-223). Note that in the initial list of 207 SAMAs, 3 items each had two variations (a and b) and 6 numbers were not used. Therefore, the initial list actually included 204 discrete candidate SAMAs. The following Table 2e-1 identifies the seven screening criteria used to screen the initial list of SAMAs and provides the number of SAMAs screened by each criterion for each unit. Table 2d-1, in the response to RAI No. 2d, provides the screening results for the plant-specific SAMAs numbered 208-223.

Table 2e-1
SAMA Analysis Screening Criteria and Screening Results

Screening Criterion	Definition	NMP1	NMP2
N/A	Indicates that the proposed SAMA is not applicable to design	39	35
A	Indicates that the proposed SAMA is related to mitigation of an Intersystem LOCA. Per Information Notice 92-36, and its supplement, ISLOCA contributes little risk for boiling water reactors because of the lower primary pressures. Because of low risk contribution due to ISLOCA, SAMA is not developed further.	9	9
B	Indicates that the proposed SAMA is related to RCP seal leakage. Review of NUREG-1560 indicates that although RCP seal leakage is important to PWRs, recirculating pump leakage does not significantly contribute to BWRs. For NMP1 design, recirculation pump seal are more important and may not be screened.	0	7
C	Indicates that the proposed SAMA has already been installed.	63	64
D	Indicates that a similar modification is addressed under another proposed SAMA.	25	29
E	Indicates that the proposed SAMA did not pass the initial screening to move into Phase II because the cost obviously exceeds the benefit, the SAMA is not feasible, or the SAMA does not provide significant benefit.	63	53
RETAIN	Indicates the SAMA was retained for detailed analysis.	5	7
Total		204	204

f. *In the NMP IPEs, several potential improvements/enhancements were identified. The current status of these improvements is not clear. Some, but not all, of these appear to be addressed by SAMAs. Discuss the implementation status of each of the potential improvements identified in the IPE. Justify the disposition of those that were not implemented and are not addressed by a SAMA.*

Response 2f

NMP1

The potential improvements/enhancements identified in the NMP1 IPE and their current status are listed below:

- Station Blackout: Procedure improvements that shed the non-safety battery loads so that it would be available as backup for recovery of AC power.

  Status: Addressed in SAMA 211

- Station Blackout: Portable battery charger to extend the coping time when AC power has been lost.

  Status: Addressed in SAMA 215

- Core Spray Injection motor-operated valve (MOV) Permissive: Ensure that Technical Support Center (TSC) guidelines identify actions to be taken if low pressure permissive has been miscalibrated.

  Status: Technical Support Reference Guide contains general guidance on system availability. EOP Support Procedure contains specific guidance on bypassing the core spray isolation valve interlocks.

- Important operator actions relative to core damage prevention:
  - AC power recovery
  - Load shedding emergency diesel given a LOCA
  - Depressurizing RPV
  - Preventing emergency condenser (EC) isolation and EC recovery after isolation
  - Feedwater control given loss of instrument air
  - DC load shedding given station blackout
  - Aligning torus cooling mode of containment spray

  Status: Complete. Input provided and incorporated into Operator Training.

NMP2

The potential improvements/enhancements identified in the NMP2 IPE and their current status are listed below:

- Containment Venting: The IPE model included a design modification for a hardened wetwell vent to be installed.

  Status: Complete; an actual hardened wetwell vent was not installed. Instead, the use of blank flanges and procedure changes were implemented, which allow for bypassing the standby gas treatment system (SGTS) filter trains.

- Auxiliary Bay Pump Room Cooling: Loss of service water scenarios result in loss of room cooling to HPCS, RCIC, and LPCI pump rooms in the auxiliary bays. It is judged that the pumps could be protected by opening doors to the pump rooms; however, there is no procedural guidance for performing these actions.

  Status: Addressed in SAMAs 23 and 213.

- Station Blackout Procedures: At the time the IPE was developed, the plant was in the process of developing procedures to implement the station blackout (SBO) analysis. The IPE model assumed these procedures had been developed and the operators trained.

  Status: Complete; procedures have been developed to address SBO scenarios.

- Station Blackout: Capability of Diesel Fire Pump (DFP) to successfully inject through canvas fire hose to the vessel.

  Status: Complete; credit for DFP injection to the RPV is limited. SAMA 216 addresses hard piping the diesel fire pump water to the RPV.

- Station Blackout: Fire water backup to cool HPCS diesel generator.

  Status: Addressed in SAMA 73.

- Station Blackout: The RCIC backpressure trip set point and the RCIC high temperature trip set point appear to be unnecessarily low. Investigate whether the set points can be set higher.

  Status: RCIC backpressure trip setpoint has been increased. The RCIC high temperature trip is bypassed per the EOPs and SOPs.

- Partial Loss of Offsite Power: The IPE models recovery from loss of one 115 kV offsite source. However, the human reliability analysis and interviews with plant staff indicate that the procedures are difficult and could be improved.

Status: Partially addressed by changes/revisions to SOP-1 and SOP-3. This is also addressed in SAMA 214.

- Service Water Recovery: A more careful analysis of system capability with less stringent success criteria may be investigated as well as recovery actions for equipment failures. In addition, more procedural guidance may be warranted. For example, no credit is given to using one service water pump to supply one train of safety equipment when the crosstie between divisions is open.

  Status: Addressed in SAMA 213.

g. *Indicate whether the external event related improvements identified for NMP in NUREG-1742 or the NMP IPEEEs have been implemented or are addressed by candidate SAMAs. Discuss the implementation status of each of the potential improvements. Justify the disposition of those that were not implemented and are not addressed by a SAMA.*

Response 2g

Implementation status of each of the external event related improvements identified for NMP in the NMP IPEEE is summarized in the following table.

Improvement	Unit	Implementation Status
Fire Analysis: Enhancement to SOP-14; Alternate Instrumentation to direct the operators to use the East and West Instrument Rooms instruments in SBO scenarios where DC power fails.	NMP1	Addressed in SAMA 209.
Seismic Analysis: A number of modifications and/or improvements/enhancements were identified to satisfy the 0.3g HCLPH screening value.	NMP1	These items were also tracked and completed under the A-46 Program.
Control Building Seismic Flood: There is a large fire water header in the Control Building corridor at elevation 261 feet.	NMP2	Although this issue was closed out in the IPEEE, it was addressed in SAMA 223.

h. *The discussion in Section F.1.5.2 dismisses the need to consider any reactor core isolation cooling (RCIC) related SAMAs even though the RRW for RCIC is the second highest. Please consider further and provide additional justification.*

Response 2h

NMPNS has considered potential Reactor Core Isolation Cooling (RCIC) system improvements/enhancements and SAMAs to improve RCIC availability. However, significant modifications such as providing redundant components are clearly not cost beneficial.

While the RCIC system initially had unavailability issues, the corrective actions and the improvement efforts associated with recent RCIC events have improved the performance and availability of the RCIC system as evidenced by the RCIC System Health Report (system is currently "Green"). NMPNS has reviewed corrective action program documentation associated with these events and could not identify any additional improvements beyond those already completed. The importance of the RCIC system is recognized, and other SAMAs (i.e., 56, 216, and 218) have been identified to mitigate the consequences of RCIC system failure.

i. *Emergency depressurization is a highly ranked operator action in both units. Please evaluate the costs and benefits of a change to the emergency operating procedures (EOPs) that would permit the actuation of the automatic depressurization system (ADS), rather than the current EOP strategy of inhibiting actuation of ADS in non-ATWS sequences.*

Response 2i

Justification and the benefits for the prevention of automatic initiation of ADS are provided in Revision 4 of the BWROG Emergency Procedure Guidelines, Appendix B: Technical Basis, Volume 1, dated September 12, 1988 (EPG). It is also noted that this information was repeated again in Revision 2 of the BWROG Emergency Operating Procedure and Severe Accident Guidelines, Appendix B: Technical Basis, Volume 1. The NRC Safety Evaluation for the BWROG Emergency Procedure Guidelines, Revision 4, approved the EPGs for implementation. NMPNS has implemented the EPGs without exception in this area, and does not believe there are any compelling reasons to take exception to this EPG/EOP action.

RAI No. 3

Please provide the following information concerning the offsite consequence portion of the SAMA evaluation:

a. *The MACCS2 analysis for both units uses a core inventory scaled by power level from a reference BWR core inventory at end-of-cycle calculated using ORIGEN. The ORIGEN calculations were based on a 3-year fuel cycle (12 month reload) with an average power density for the assembly groups ranging from 24 to 30 MW/MTU. Current BWR fuel management practices use longer fuel cycles (time between refueling) and result in significantly higher fuel burnups. The use of the reference BWR core instead of a plant specific cycle could significantly underestimate the inventory of long-lived radionuclides important to population dose (such as Sr-90, Cs-134 and Cs-137), and thus impact the SAMA evaluation. Justify the adequacy of the SAMA screening and dispositioning given the fuel enrichment and burnup expected at NMP during the renewal period.*

Response 3a

NMPNS has determined that a General Electric (GE)-produced core inventory exists for NMP2 that is specific to the current six-year fuel cycle (24-month reload) and utilizes the highest allowable enrichment for that cycle design. A preliminary analysis has been performed to determine if, using this inventory, there is a significant effect on the LRA ER SAMA results. The results of the preliminary analysis indicate minimal effect on the SAMA analysis. This is consistent with the core power level sensitivity analysis results presented in LRA ER Section F.2.3; however, NMPNS will perform a formal reanalysis of the NMP2 SAMA results based on the GE-produced core inventory. For NMP1, a bounding analysis approach will be used. NMPNS will complete the reanalysis and submit a final RAI response for NRC review by January 31, 2005.

b. *Provide the release fractions, release time and duration, warning time, release height and release energy used in the MACCS2 analysis for each of the release categories and the source and/or basis for these values.*

Response 3b

Tables 3b-1 and 3b-2 provide the details of potential releases by release category for NMP1, and Tables 3b-3 and 3b-4 provide the same information for NMP2.

Table 3b-1
NMP1 Release Details by Release Category

Release Category	Plume No	Time to Notification (sec)	Height above Ground (m)	Release Duration (sec)	Start of Release (sec)	Release Energy (watt)	NG	I	Cs	Te	Sr	Ru	La	Ce	Ba
EHGH	1	3,600	30	180	7,200	8.8E+06	0.75	4.2E-03	4.1E-03	1.8E-03	3.8E-04	2.7E-04	8.6E-05	1.3E-04	4.5E-04
	2			14,000	7,380	3.7E+05	0.25	9.1E-02	9.3E-02	4.1E-02	4.2E-02	4.7E-04	2.8E-03	5.5E-03	3.2E-02
IHGH	1	21,600	30	180	25,200	8.8E+06	0.75	4.2E-03	4.1E-03	1.8E-03	3.8E-04	2.7E-04	8.6E-05	1.3E-04	4.5E-04
	2			14,000	25,380	3.7E+05	0.25	9.1E-02	9.3E-02	4.1E-02	4.2E-02	4.7E-04	2.8E-03	5.5E-03	3.2E-02
LHGH	1	21,600	30	180	57,600	2.0E+07	0.75	2.1E-03	2.1E-03	9.0E-04	1.9E-04	1.4E-04	4.3E-05	6.5E-05	2.3E-04
	2			14,000	57,780	3.7E+05	0.25	4.6E-02	4.7E-02	2.1E-02	2.1E-02	2.4E-04	1.4E-03	2.8E-03	1.6E-02
EMED	1	3,600	30	180	7,200	8.8E+06	0.75	2.1E-03	2.1E-03	9.0E-04	1.9E-04	1.4E-04	4.3E-05	6.5E-05	2.3E-04
	2			14,000	7,380	3.7E+05	0.25	4.6E-02	4.7E-02	2.1E-02	2.1E-02	2.4E-04	1.4E-03	2.8E-03	1.6E-02
IMED	1	21,600	30	180	25,200	8.8E+06	0.75	2.1E-03	2.1E-03	9.0E-04	1.9E-04	1.4E-04	4.3E-05	6.5E-05	2.3E-04
	2			14,000	25,380	3.7E+05	0.25	4.6E-02	4.7E-02	2.1E-02	2.1E-02	2.4E-04	1.4E-03	2.8E-03	1.6E-02
LMED	1	21,600	30	180	57,600	2.0E+07	0.75	2.1E-03	2.1E-03	9.0E-04	1.9E-04	1.4E-04	4.3E-05	6.5E-05	2.3E-04
	2			14,000	57,780	3.7E+05	0.25	4.6E-02	4.7E-02	2.1E-02	2.1E-02	2.4E-04	1.4E-03	2.8E-03	1.6E-02
ELO	1	3,600	30	180	7,200	8.8E+06	0.75	4.2E-04	4.1E-04	1.8E-04	3.8E-05	2.7E-05	8.6E-06	1.3E-05	4.5E-05
	2			14,000	7,380	3.7E+05	0.25	9.1E-03	9.3E-03	4.1E-03	4.2E-03	4.7E-05	2.8E-04	5.5E-04	3.2E-03
ILO	1	21,600	30	180	25,200	2.0E+07	0.75	4.2E-04	4.1E-04	1.8E-04	3.8E-05	2.7E-05	8.6E-06	1.3E-05	4.5E-05
	2			14,000	25,380	3.7E+05	0.25	9.1E-03	9.3E-03	4.1E-03	4.2E-03	4.7E-05	2.8E-04	5.5E-04	3.2E-03
LLO	1	21,600	30	180	57,600	2.0E+07	0.75	4.2E-04	4.1E-04	1.8E-04	3.8E-05	2.7E-05	8.6E-06	1.3E-05	4.5E-05
	2			14,000	57,780	3.7E+05	0.25	9.1E-03	9.3E-03	4.1E-03	4.2E-03	4.7E-05	2.8E-04	5.5E-04	3.2E-03
NOREL	1	21,600	30	9,000	22,000	1.5E+05	2.5E-03	5.6E-04	1.4E-08	5.9E-09	4.1E-09	2.7E-10	2.7E-10	5.9E-10	3.4E-09
	2			22,000	31,000	2.5E+05	2.5E-03	5.6E-04	1.4E-08	5.9E-09	4.1E-09	2.7E-10	2.7E-10	5.9E-10	3.4E-09

Table 3b-2
NMP1 Notification and Release Times

Release Description	Notification Time (hr)	Release Time (hr)	Basis
Early	1	2	Latest notification time and earliest release time for EHGH events. EMED and ELO are bounded.
Intermediate	6	7	By definition, the time period of this release is between 6 and 24 hours after event initiation. For IHGH, notification is assumed to occur at 6 hours following event initiation, and the time delay to release is conservatively assumed to be the same as for EHGH, 1 hour, so a release time of 7 hours following event initiation is used. IMED and ILO are bounded.
Late	6	16	By definition, the time period of this release starts at 24 hours after event initiation. Notification is assumed to occur at 6 hours following event initiation. The time delta between notification and release is important with respect to offsite consequences and these scenarios could result in core damage many hours after event initiation, so 10 hours is conservatively chosen as a delta between notification and release for the LHGH release, resulting in a release time of 16 hours following event initiation. LMED and LLO are bounded.
NOREL	6	-	By definition, releases do not apply. The analyzed scenarios are similar to those in the above releases with respect to core damage timing in the 6 to 8 hour time frame, so 6 hours was selected.

Table 3b-3
NMP2 Release Details by Release Category

Release Category	Plume No	Time to Notification (sec)	Height above Ground (m)	Release Duration (sec)	Start of Release (sec)	Release Energy (watt)	NG	I	Cs	Te	Sr	Ru	La	Ce	Ba
EHGH	1	3,600	30	180	7,200	8.8E+06	0.75	4.2E-03	4.1E-03	1.8E-03	3.8E-04	2.7E-04	8.6E-05	1.3E-04	4.5E-04
	2			14,000	7,380	3.7E+05	0.25	9.1E-02	9.3E-02	4.1E-02	4.2E-02	4.7E-04	2.8E-03	5.5E-03	3.2E-02
IHGH	1	3,600	30	180	21,600	1.7E+07	0.75	2.1E-03	2.1E-03	9.0E-04	1.9E-04	1.4E-04	4.3E-05	6.5E-05	2.3E-04
	2			14,000	21,780	3.7E+05	0.25	4.6E-02	4.7E-02	2.1E-02	2.1E-02	2.4E-04	1.4E-03	2.8E-03	1.6E-02
LHGH	1	57,600	30	180	86,400	5.2E+07	0.75	8.4E-03	8.2E-03	3.6E-03	7.6E-04	5.4E-04	1.7E-04	2.6E-04	9.0E-04
	2			14,000	86,580	3.7E+05	0.25	1.8E-01	1.9E-01	8.2E-02	8.4E-02	9.4E-04	5.6E-03	1.1E-02	6.4E-02
EMED	1	3,600	30	180	7,200	2.8E+07	0.75	2.1E-03	2.1E-03	9.0E-04	1.9E-04	1.4E-04	4.3E-05	6.5E-05	2.3E-04
	2			14,000	7,380	3.7E+05	0.25	4.6E-02	4.7E-02	2.1E-02	2.1E-02	2.4E-04	1.4E-03	2.8E-03	1.6E-02
IMED	1	3,600	30	180	21,600	1.7E+07	0.75	2.1E-03	2.1E-03	9.0E-04	1.9E-04	1.4E-04	4.3E-05	6.5E-05	2.3E-04
	2			14,000	21,780	3.7E+05	0.25	4.6E-02	4.7E-02	2.1E-02	2.1E-02	2.4E-04	1.4E-03	2.8E-03	1.6E-02
LMED	1	57,600	30	180	86,400	2.0E+07	0.75	2.1E-03	2.1E-03	9.0E-04	1.9E-04	1.4E-04	4.3E-05	6.5E-05	2.3E-04
	2			14,000	86,580	3.7E+05	0.25	4.6E-02	4.7E-02	2.1E-02	2.1E-02	2.4E-04	1.4E-03	2.8E-03	1.6E-02
ELO	1	3,600	30	180	7,200	8.8E+06	0.75	4.2E-04	4.1E-04	1.8E-04	3.8E-05	2.7E-05	8.6E-06	1.3E-05	4.5E-05
	2			14,000	7,380	3.7E+05	0.25	9.1E-03	9.3E-03	4.1E-03	4.2E-03	4.7E-05	2.8E-04	5.5E-04	3.2E-03
ILO	1	3,600	30	180	21,600	2.0E+07	0.75	4.2E-04	4.1E-04	1.8E-04	3.8E-05	2.7E-05	8.6E-06	1.3E-05	4.5E-05
	2			14,000	21,780	3.7E+05	0.25	9.1E-03	9.3E-03	4.1E-03	4.2E-03	4.7E-05	2.8E-04	5.5E-04	3.2E-03
LLO	1	57,600	30	180	86,400	2.0E+07	0.75	4.2E-04	4.1E-04	1.8E-04	3.8E-05	2.7E-05	8.6E-06	1.3E-05	4.5E-05
	2			14,000	86,580	3.7E+05	0.25	9.1E-03	9.3E-03	4.1E-03	4.2E-03	4.7E-05	2.8E-04	5.5E-04	3.2E-03
NOREL	1	3,600	30	9,000	22,000	1.5E+05	2.5E-03	5.6E-04	1.4E-08	5.9E-09	4.1E-09	2.7E-10	2.7E-10	5.9E-10	3.4E-09
	2			22,000	31,000	2.5E+05	2.5E-03	5.6E-04	1.4E-08	5.9E-09	4.1E-09	2.7E-10	2.7E-10	5.9E-10	3.4E-09

Table 3b-4
NMP2 Notification and Release Times

Release Description	Notification Time (hr)	Release Time (hr)	Basis
Early	1	2	Latest notification time and earliest release time for EHGH events are listed. EMED and ELO are bounded.
Intermediate	1	6	By definition, the time period of this release is between 6 and 24 hours after event initiation. For IHGH, the notification timing is the same as the early releases, but release time is later because early containment failure does not occur immediately. The time of release is at least 6 hours after event initiation. IMED and ILO are bounded.
Late	16	24	By definition, the time period of this release starts at 24 hours after event initiation. Latest release notification time and earliest release time for LHGH events are used. LMED and LLO are bounded.
NOREL	1	-	By definition, releases do not apply. The containment is intact with containment heat removal. The dominant sequences result in an early release notification.

Notes for Tables 3b-1 through 3b-4:

1. **Radiological Release:** Radiological release fractions are from NUREG/CR-4551, Vol. 4, Rev. 1, Part 1, "Evaluation of Severe Accident Risks: Peach Bottom Unit 2."

2. **Timing:** Notification and release times for both units are based on plant-specific evaluations of dominant sequence timing, including MAAP calculations. The dominant sequences for each release category were evaluated to determine timing. Three conditions were identified as key to meeting the "General Emergency" classification:

   - RPV level,
   - ATWS conditions and heat capacity temperature limit (HCTL), and
   - Containment over pressure conditions and primary containment pressure limit (PCPL).

3. **Release Height:** Regardless of the failure location, it is expected that the building siding will blow out and most releases will pass up through the building and be released near the refueling level at 30 meters above ground.

4. **Release Energy:**

   NMP1 Energies - The first plume energies of release were based upon NMP2 plant-specific containment failures and MAAP calculations. Since the NMP1 containment failure pressures are less than NMP2, these assumptions are bounding. For the second plume, the release energy was taken from NUREG/CR-4551, Vol. 4, Rev. 1, Part 1, because it is applicable to expected major NMP1 releases without containment spray.

   NMP2 Energies - The energies of release for the first plume were estimated from NMP2 plant-specific containment failures and MAAP calculations. For the second plume, the energies given in NUREG/CR-4551, Vol. 4, Rev. 1, Part 1 were used since, as with NMP1, they are applicable to expected major NMP2 releases without containment spray.

5. **Duration of Releases:** All durations, including NOREL, were taken from NUREG/CR-4551, Tables 3.3-1 through 3.3-9. For the first plume, 180 seconds is used for all release categories except NOREL because large containment failures and energies of release are assumed. The duration of the second plume is also relatively short at 14,000 seconds because of the conservative energy and failure assumptions. All NOREL cases in NUREG/CR-4551 have the same duration.

RAI No. 4

In Section F.1.6 it is stated that "although an uncertainty distribution has not been created for the NMP CDF and LERF, uncertainty is considered in the model development and risk applications," and that a "comparison between the 95 percent values of the quantified models is not expected to affect the conclusion unless a major change aimed at reducing uncertainty is proposed." Given that 95th percentile values are typically about a factor of two to three higher than mean values, identify and provide a further evaluation of those SAMAs that are within a factor of two to three of being cost beneficial. This evaluation can be based on more realistic estimates of risk reduction and implementation costs, and deterministic considerations, including potential negative implications of candidate SAMAs.

Response 4

NMP1

NMPNS review of the SAMA results for NMP1 indicates that three of the SAMAs with a negative net benefit are within a factor of 2 to 3 of being cost beneficial:

- SAMA U1-211 – Reduce Offsite Dependency on DC11
- SAMA U1-212 – Capability to Manually Operate Containment Venting
- SAMA U1-220 – Installation of New Transformers to Improve AC Power Load Management

SAMA U1-211 is within a factor of 3 of being cost beneficial. NMPNS notes that SAMA U1-215 has a positive net benefit and provides a more reliable alternative for addressing the vulnerability associated with reducing the dependency on offsite power. In addition, NMPNS notes that implementation of SAMA U1-215 will reduce the magnitude of the benefit calculated for U1-211. Therefore, further evaluation for U1-211 is not warranted.

NMPNS notes that SAMA U1-212 is within a factor of 2 and is already recognized as cost beneficial using the 3 percent discount factor.

SAMA U1-220 is within a factor of 3 of being cost beneficial; however, implementation of this modification is not warranted at this time because conservatism exists in the model and applying an additional factor of 3 is not realistic. In addition to the model conservatism, the cost of enhancement estimates that were provided for the SAMA analyses tended to be conservative. It is expected that when a detailed cost estimate for the evaluation of this modification is performed, the actual cost of the modification will be higher than the value used for the SAMA analysis.

NMP2

MNPNS review of the SAMA results for NMP2 indicates that two of the SAMAs with a negative benefit are within a factor of 2 to 3 of being cost beneficial:

- SAMA U2-219 – Improve Containment Venting
- SAMA U2-223 – Improve Control Building Flooding Scenrios

SAMA U2-219 is within a factor of 3 of being cost beneficial. NMPNS conservatively modeled the benefit of fully automating containment venting (i.e., no consideration of competing risks associated with automated venting), and as noted in Section F.3 of the LRA ER, a minimal cost estimate (i.e., engineering costs only) was prepared. It is also noted that significant regulatory hurdles to circumvent containment closure requirements and deliberate venting procedures would have to be addressed. If a modification to automatically vent containment were approved, it would involve installation of multiple valves and operators, hard piping, valve actuation circuitry, and logic. Both of these considerations would increase the cost estimate significantly. NMPNS considers the additional costs involved with implementation of the SAMA to easily exceed an additional $250,000 such that the total cost would exceed 3 times the benefit. Therefore, no additional analysis is warranted.

NMPNS notes that SAMA U2-223 is within a factor of 2 of being cost beneficial and is already recognized as cost beneficial using the 3 percent discount factor.

RAI No. 5

Please provide the following additional information concerning the SAMA assessments described in Section F.3 of the ER:

a. *For SAMA U1-208, eliminating all drywell failure modes results in only a 0.06% (0.013 person-rem/year) reduction in population dose. This appears to be counter-intuitive since releases via the drywell (which are unscrubbed) would be expected to have greater consequences than releases via the wetwell (which would be scrubbed.) Also, Figure 4.6-17 of the Unit 1 IPE indicates that shell and drywell head failures make up 41% of the total releases. A similar situation exists for SAMA U2-208. Please explain why the eliminating all drywell failure modes results in such a small risk reduction for both units.*

Response 5a

Shell failure at NMP1 is modeled in a different event tree top event than used in the SAMA analysis calculation. The only failure mode evaluated in the SAMA analysis is drywell head bolts (replace with stronger bolts). This failure mode is assumed to apply to the containment over-pressure failure mode (top events DI/DC). This failure mode applies mostly to late releases and is not a significant contributor to release. Note that there are other top events in the Level 2 model that result in containment failure other than top events DI/DC.

b. *For SAMA U1-222, rather than assuming complete elimination of the associated operator action (and in turn, assuming that a hardware modification would be needed to achieve this risk reduction) it appears that an improvement to the existing procedures and training that provides just a factor of two reduction in the human error probability (HEP) would be cost beneficial. Provide further justification that improved procedures and training alone would not be cost beneficial.*

Response 5b

Improvements in procedures and training are always possible; however, it is the judgment of NMPNS that the procedures appear to already address the actions intended and that an expert evaluation of procedures and training alone would likely cost as much as the benefit of a factor of two reduction. The cost of actually implementing procedure changes and training would provide additional cost.

c. *For SAMA U2-21, the evaluation indicates that there is no reduction in CDF because of the dependency of residual heat removal (RHR) pump room cooling on service water. However, this dependency would be eliminated if SAMA U2-23a (separately determined to be cost beneficial) is implemented. Please provide a re-assessment of SAMA U2-21 under this condition.*

Response 5c

The benefit of SAMA U2-21, including implementation of SAMA U2-23a and the portable battery charger of SAMA 215, was estimated to be approximately $150K. Although a walkdown and detailed cost estimate have not been performed, the cost of running fire water piping and connecting into the RHR heat exchangers would likely be two to three times this benefit.

d. *SAMA U2-73 considers the use of firewater as a backup for emergency diesel generator cooling. As indicated in the benefit assessment for SAMA U2-56, the high pressure core spray (HPCS) emergency diesel generator (EDG) is dependent on the other EDGs to provide support for service water. Provide an assessment of the cost and benefit associated with providing firewater backup for the HPCS generator alone.*

Response 5d

Providing firewater as a backup to the HPCS diesel generator for cooling was originally considered after the IPE. The benefit of this proposal was not judged to be as reliable as injecting fire water directly to the RPV via the RHR piping during station blackout. Thus, the benefits are expected to be lower. Also, the running of piping to the diesel generator was judged to be more difficult than doing it in the Reactor Building for the RHR injection path. In summary, although detailed analysis was not performed, the firewater injection option was judged to provide greater benefit and to be easier to implement.

e. *The discussion in Section 4.16.5.2 indicates that the implementation of SAMAs U2-23a, b and c and U2-213 should be considered as a combination since loss of service water (addressed by SAMA U2-213) is an important contributor and cause of room cooling failure (addressed by SAMA U2-23). Please clarify the relationship between SAMA U2-213 and SAMAs U2-23a, b and c. Would SAMA U2-213 be implemented in addition to SAMA U2-23a, b or c, or might only one of these SAMAs be implemented (e.g., SAMA U2-213 or one of the variants of SAMA U2-23)?*

Response 5e

NMPNS has identified both SAMA U2-23 (all three variants) and SAMA U2-213 for implementation. The procedural changes identified in SAMA 23 to reduce risk should be completed first since it is anticipated that such changes to reduce the risk of room cooling should be made for the most general case (e.g., high room temperature alarm), which may or may not be due to loss of service water. It may be appropriate for the loss of service water procedure to also refer to these losses of room cooling procedure changes as a result of SAMA 23.

f. *For SAMA U2-223, the evaluation is based on both procedural and structural modifications. Please provide an evaluation of the costs and benefits of this SAMA considering only the lower cost procedural modifications.*

Response 5f

SAMA U2-223 has been identified as potentially cost-beneficial and NMPNS is retaining this SAMA to evaluate it for implementation. Implementation evaluation will address the most economically viable modification as part of the normal plant modification evaluation process. This detailed evaluation has not yet been performed for this modification; therefore, the details that would result from that evaluation are not yet available.

RAI No. 6

Licensees for other BWR plants identified the following procedural-related SAMAs as potentially cost-beneficial:

(1) Provide a means for alternate safe shutdown makeup pump room (or equivalent room) cooling, either via the use of the fire protection system, or procedures to open doors and use portable fans.

(2) Provide procedures for (a) bypassing major DC buses; (b) locally starting equipment.

(3) Develop procedures to control feedwater flow without 125 VDC to prevent tripping feedwater on high/low level.

(4) Develop procedures to terminate reactor depressurization at a pressure at which RCIC remains operable.

(5) Develop or enhance procedures to control containment venting within a narrow band of pressure to avoid adverse impacts on ECCS injection.

(6) Develop procedures to use a cross connect to the other unit's containment cooling service water as an alternate containment spray source.

(7) Develop procedures to align LPCI or core spray to the condensate storage tank on loss of suppression pool cooling.

(Numbering added for clarity.)

Based on the information provided in the ER, it is not clear whether these SAMAs or equivalents were addressed in the SAMA analysis for NMP. Provide an assessment of the applicability/feasibility of these SAMAs for NMP.

Response 6

The following is an assessment of the applicability/feasibility for each of the items listed in the RAI, for each NMP unit.

<u>NMP1</u>

(1) The reference to alternate safe shutdown room cooling would relate to the corner rooms at NMP1. Reactor building ventilation failure would not affect corner room equipment as room temperature is expected to be limited to 138°F. Equipment is qualified to 140°F for more than 24 hours.

(2) Guidance for bypassing major DC buses is provided in operating procedures. NMP1 has the capability to supply many critical loads from the opposite DC division given failure of a

divisional DC bus. NMP1 operators currently have the capability to locally start equipment should 125 VDC failure preclude remote operation. This would be accomplished by manually operating circuit breakers locally. It should be noted that this has not yet been credited in the PRA.

(3) NMP1 has the procedural guidance and capability to locally control feedwater flow control valves given loss of instrument air or control power.

(4) The RCIC question does not specifically apply to NMP1. However, the intent of the question does apply to the emergency condensers (ECs). Such a process is not needed at NMP1 because ECs provide RPV level control and containment heat removal. If ECs are operable, no depressurization should be necessary. If depressurization is necessary for any other reason (e.g., LOCA), ECs are not likely to provide a significant benefit.

(5) The NMP1 PRA does not credit core spray suction from the suppression pool under containment venting situations and such a strategy is unlikely to create a significant benefit (see response to RAI No. 1f). Under such scenarios, NMP1 would rely on feedwater, CRD, containment spray raw water aligned to core spray, or fire water for RPV injection. RRW for top event OR2 (injection after containment venting) is about 1.005, which indicates a low benefit of protecting core spray. The minimal benefit of such a primary containment pressure control process is believed to be offset by making the containment venting process more cumbersome for the operators.

(6) NMP1 does not have a piping cross-connection of the type described in the RAI. Installation of such a piping configuration would be costly and would also introduce additional internal flood contributors, a competing risk. NMP1 currently has options for injection from outside sources and an additional source is judged to have minimal benefit.

(7) NMP1 has a procedure to transfer core spray suction from the torus to the condensate storage tank (CST). The RPV Control EOP also includes a caution to remind operators about core spray net positive suction head (NPSH). Note that this is not modeled in the PRA and would have limited benefit.

<u>NMP2</u>

(1) The reference to alternate safe shutdown room cooling would relate to the emergency core cooling system pump rooms at NMP2. This has been included as SAMA 23 and, since service water provides the unit cooler heat sink, SAMA 213 also applies.

(2) NMP2 has, by design, strict separation of safety-related electrical divisions. For 125 VDC power, the system was reviewed and no simple and useful means of bypassing major buses was discovered. This is not significant since, as with NMP1, NMP2 operators have the capability to locally operate circuit breakers should remote control power be unavailable. It should be noted that this has not yet been credited in the PRA.

(3) The NMP2 feedwater flow control valves are supplied from non-safety-related AC power; therefore, loss of 125 VDC will have minimal impact on the ability to control RPV water level. Loss of 125 VDC will affect the ability to stop and start condensate and feedwater loads from the control room; however, in the field, operators can perform this task locally at the load supply breakers. Additionally, the normal 13.8 kV and 4.16 kV switchgear are designed with the feature of being able to use either of two 125 VDC sources for control power to line and load breakers. The direction for switching from one DC source to the other exists in current NMP2 operating procedures.

In the event the level control valves cannot be operated from the control room (i.e., loss of AC power), a special operating procedure for feedwater system failures provides alternate methods of controlling RPV level up to and including taking local manual control of the level control valves at the feedwater pumps. Also, NMP2 has HPCS and RCIC systems capable of high-pressure RPV injection, independent of feedwater.

(4) To develop/revise procedures to terminate reactor depressurization at a pressure at which RCIC remains operable would result in a conflict with the BWROG Emergency Procedure Guidelines/Severe Accident Guidelines section on Emergency RPV Depressurization (Contingency 2). The purpose of the guideline is to depressurize the RPV and keep it depressurized, thereby maintaining the RPV at its lowest energy state and allowing injection by low pressure makeup sources to provide adequate core cooling.

The most likely scenario where this condition is an issue is SBO. For this case, the NMP2 EOPs include a heat capacity temperature limit (HCTL) curve that has been expanded to prolong depressurization.

Once HCTL is exceeded, in any scenario, the safety relief valves (SRVs) are opened to maintain RPV pressure no greater than 40 psi above containment pressure. This is done to protect the primary containment, consistent with the design basis of the plant. Attempting to implement an alternate (i.e., higher) blowdown pressure to maintain RCIC operable is judged to involve significant analytical cost, as well as being an exception to the industry Emergency Procedure Guidelines.

The benefit is small, except as noted for SBO cases above, because:

- Such depressurization would only be caused by loss of DHR conditions; extended RCIC operation does not directly lead to success unless DHR is also recovered.

- Non-SBO sequences where RCIC is the only injection source are very low frequency.

- Maintaining a higher blowdown pressure increases the containment challenge, which could lead directly or indirectly to RCIC failure and/or core damage.

- SAMA 216 provides an alternate injection source that does not require AC power or suction from the suppression pool.

(5) NMP2 does not require such a procedure because low pressure core spray and LPCI pumps are designed to operate with the suppression pool water at 212°F.

(6) NMP1 does not have a piping cross-connection of the type described in the RAI. Installation of such a configuration would be costly and would also introduce additional internal flood contributors, a competing risk. NMP2 currently has options for injection from outside sources and an additional source is judged to have minimal benefit.

(7) This is not a significant benefit at NMP2 because the ECCS pumps are designed to operate with the suppression pool water at 212°F.

ATTACHMENT 2

Nine Mile Point Nuclear Station

Probabilistic Risk Assessment Sections

Related to the Seismic Model

This attachment provides copies of major sections of the Nine Mile Point Unit 1 (NMP1) and Nine Mile Point Unit 2 (NMP2) Probabilistic Risk Assessments (PRAs) related to the seismic model for each unit. The following PRA sections are included:

NMP1

- Section 3.2.1.7, Seismic Event Tree Model
- Section 4.2.30, Seismic – Component Fragilities & Failure Modes
- Section 5.3.4, Seismic Initiating Events

NMP2

- Section 3.2.1.7, Seismic Accident Sequence Model
- Section 4.2.30, Seismic – Component Fragilities
- Section 5.3.4, Seismic Initiating Events

Nine Mile Point Unit 1

Probabilistic Risk Assessment Sections Related to the Seismic Model

- Section 3.2.1.7, Seismic Event Tree Model
- Section 4.2.30, Seismic – Component Fragilities & Failure Modes
- Section 5.3.4, Seismic Initiating Events

3.2.1.7 Seismic Event Tree Model

As shown in Figure 3-1, seismic initiating events utilize the SEIS event tree in Figure 3.2.1.7-1 to assess the fragility of the plant. After the SEIS event tree, the model utilizes the same event trees used in the transient analysis (support system event trees in Section 3.2.1.1 and transient event trees in Section 3.2.1.2). Seismic initiating events are described in Sections 3.1.4 and 5.3.4. As described in Section 3.2.1.8, the SEIS event tree also contains top events utilized for certain fire initiating events.

The SEIS event tree and overall seismic model development are described in the following subsections.

3.2.1.7.1 SEIS Event Tree Model

The following summarizes the SEIS event tree top event fragility's described in Section 4.2.30:

COMP1 - Large Early Release (Structural) represents a fragility with capacity greater than the plant fragility (COMP2 below) and is based on judgment. It is included in the model to explicitly address the likelihood of large early release due to structural, passive type failure modes (e.g., containment, penetration, pipe, and valves). Most of these components are judged to have significant margin above the screening value (COMP2). For example, the drywell is estimated to have HCLPF >0.5g. Assessment of the torus indicated a HCLPF of 0.32, but it was acknowledged as being conservative. The same can be said of reactor internals and other potential contributors to large early release which were not evaluated in detail, but all have capacity >0.3g. A fragility with a HCLPF of 0.5g is used in the base PRA model to obtain some realism in this area that has not been evaluated in detail. Failure of top event COMP1 guarantees a large early release by failing reactivity control (RQ=F) and binning the sequences to Class IVL which ensure an early large release in the Level 2 model.

COMP2 - Plant HCLPF represents the screening level, 0.3g HCLPF, used in the seismic analysis. Since a few components marginally met this screening criteria and little is know about how much more margin exists, failure of COMP2 guarantees core damage. Both IPEEE and A-46 scope equipment with a 0.3g HCLPF are credited in the PRA model if COMP2 is successful. Failure of COMP2 guarantees core damage (e.g., AC and DC power is set to guaranteed failure in the SUP1 event tree to ensure core damage occurs).

COMP3 - Non A-46 Fragility includes the probability that there is a small LOCA and/or other non A-46 equipment failures due to the earthquake. Note that all equipment dependent on normal AC power is addressed by COMP4 below. In the IPEEE, a small LOCA was assumed and no credit was taken for instrument air in developing the success paths. A small LOCA fragility with a HCLPF of 0.2g is assumed in the base PRA model. Failure of COMP3 guarantees a small LOCA and loss of instrument air in the PRA model.

COMP4 - Offsite Power Fragility is known to have a relatively low fragility and is used, as the fragility for all other components not evaluated in the seismic analysis. This fragility also provides a lower bound seismic impact on the plant. Loss of offsite power makes several key plant systems unavailable (e.g., condensate, feedwater, and main condenser), challenges relief valves (e.g., stuck open relief valve results in LOCA condition), and challenges emergency diesels. Failure of COMP4 guarantees failure of offsite power and all systems dependent on normal AC power. Success of COMP4 is modeled similar to turbine trip initiator for seismic initiating events even though seismic plant trips that do not cause loss of offsite power are bounded in frequency and impact by the PRA model of non seismic plant initiators. The diesel fire pump is also guaranteed to fail if COMP4 fails; this is judged to be conservative.

Other top events in the SEIS event tree are described in Section 3.2.1.8 since they are utilized for certain fire initiating events.

3.2.1.7.2 Seismic Model Development

Functional success paths and then progressively more detailed success paths considering frontline and support systems were defined using the PRA model developed for internal initiating events. Components supporting these systems as well as the structures that house these components were identified. Also, a relay chatter evaluation was performed to identify those relays that could potentially effect the success paths. Structures, systems, and components identified were evaluated for seismic capabilities including seismic qualification, analysis, and test information that would support screening. Calculations were performed as necessary to support screening.

Given COMP2 (and COMP1) success in the SEIS tree (i.e., no guaranteed core damage), a simplified representation of the success paths in the seismic model is provided in Figure 3.2.1.7-2. Note the shaded paths represent redundant IPEEE success paths, non-shaded paths represent possible success paths not credited in the IPEEE. In the seismic PRA, non-shaded paths are also credited if COMP3 is successful (e.g., no LOCA and instrument air is available). This is included to remove IPEEE conservatism and allow assessment of this conservatism.

In the seismic PRA model, seismic initiators are treated as a plant trip with no other impacts unless one of the top events in the SEIS event tree fails. Note that the frequency of plant scram or turbine trip due to an earthquake with offsite power and balance of plant equipment available is bounded by the normal scram and turbine trip initiating events, which are also included in the PRA model. Consistent with other seismic PRAs, loss of feedwater, main condenser and their support systems is assumed incorporated within the loss of offsite power fragility. This is a reasonable assumption since offsite power has been assessed to be the weak link and this is based on actual earthquake experience.

Human Response: There are human actions considered relatively important to the accident sequence model and described below. The following actions are required to support the shaded path (COMP2 success) in Figure 3.2.1.7-2:

- Establishing the heat removal function requires the operators to start and align containment spray raw water to containment spray heat exchangers. The operators have several hours to perform this action, it is proceduralized, and the actions can be accomplished from the control room.

- Shedding diesel loads during LOCA conditions is required and modeled in the PRA. Given loss of offsite power and LOCA conditions, this would be required if the operators successfully reset lockout relays and started a number of pumps (i.e., CRD, RBCLC, service water and Power Board 16A/B-17A/B tie breakers) which are not necessarily required during a LOCA. This action is proceduralized and expected to be reliable because if the operators reset relays and start equipment which would have to be available after the seismic event to overload the diesel, they also would be expected to control diesel loading.

The following actions would be required to support the secondary non-shaded success paths in Figure 3.2.1.7-2 (COMP3 success):

- Torus cooling and containment venting - the operators have several hours to utilize these success paths even without support systems.

- Given loss of normal AC power, the operators have to reset lockout relays in the control room before RBCLC, service water, shutdown cooling, and instrument air can be restarted.

- Other operator actions associated with long term EC control & makeup, SDC alignment, restarting CRD pumps, and other support systems (i.e., RBCLC, service water, instrument air compressors) are associated with secondary success paths.

The PRA models an operator action to manually depressurize the RPV at top of active fuel when high-pressure injection systems are unavailable. It is assumed that the operators correctly inhibited ADS per the EOPs, thus, requiring this operator action to provide successful low-pressure injection. If the operators correctly inhibit ADS after an earthquake, there is no reason to believe that they would not depressurize the RPV at top of active fuel per the EOPs. This assumption reinforces the importance of level instrumentation. Also, the equipment necessary to actuate ADS automatically is included in seismic scope (COMP2 success).

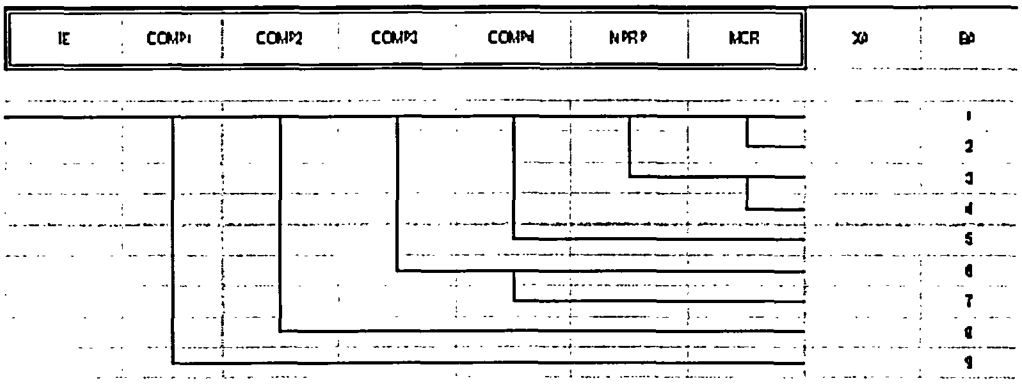
Other potential operator actions that are not included:

- The fragility of the vapor suppression function is high; the operators can mitigate this failure by initiating containment spray, emergency depressurizing the RPV, or venting containment, if available.

- The fragility of room cooling equipment is not considered important mostly due to low dependency of equipment on room cooling; the operators have time to open doors and perform actions identified in the PRA.

- Automatic actuation of systems, including ADS, has a high fragility; manual initiation of systems could be considered.

Figure 3.2.1.7-1 SEIS Event Tree Model



Top Event	Top Event Description
COMP1	Seismic Fragility of Containment (LERF)
COMP2	Seismic Fragility of Plant (CDF)
COMP3	Seismic Fagility of A-46 (SLOCA)
COMP4	Seismic Fragility of BOP (LOSP)
NPRP	No Fire Propagation in Aux Control Room
MCR	Operators Remain in CR during CR Fire

Figure 3.2.1.7-1 SEIS Event Tree Model Macros and Split Fractions

Macro	Macro Rule/Comment
FACR	INIT=FC21+INIT=FC22+INIT=FC23+INIT=FC24+INIT=CFC21+INIT=CFC22+ INIT=CFC23+INIT=CFC24
FCSR	INIT=FC11+INIT=FC12+INIT=CFC11+INIT=CFC12
FIRE	FMCR+FACR+FCSR+FT2A+FT2B+FT2D+FT3B All initiators are repeated with "C" for Level 2 quantification
FMCR	INIT=FC31+INIT=FC32+INIT=FC33+INIT=FC34+INIT=FC35+INIT=CFC31+ INIT=CFC32+INIT=CFC33+INIT=CFC34+INIT=CFC35
FT2A	INIT=FT2A1+INIT=CFT2A1
FT2B	INIT=FT2B1+INIT=FT2B4+INIT=CFT2B1+INIT=CFT2B4
FT2D	INIT=FT2D1+INIT=CFT2D1
FT3B	INIT=FT3B1+INIT=FT3B2+INIT=FT3B3+INIT=CFT3B1+INIT=CFT3B2+INIT=CFT3B3
SEIS	SEISA + SEISB SIESA initiators are used in Level 1, SIESB initiators are used in Level 2
SEISA	INIT=SEIS1+INIT=SEIS2+INIT=SEIS3+INIT=SEIS4+INIT=SEIS5+INIT=SEIS6
SEISB	INIT=CSEIS1+INIT=CSEIS2+INIT=CSEIS3+INIT=CSEIS4+INIT=CSEIS5+INIT=CSEIS6

Split Fraction	Split Fraction Assignment Rule
COMP1S	-SEIS
COMP11	INIT=SEIS1+INIT=CSEIS1 Comments All initiators repeated with "C" to quantify Level 2 model
COMP12	INIT=SEIS2+INIT=CSEIS2
COMP13	INIT=SEIS3+INIT=CSEIS3
COMP14	INIT=SEIS4+INIT=CSEIS4
COMP15	INIT=SEIS5+INIT=CSEIS5
COMP16	INIT=SEIS6+INIT=CSEIS6
COMP2S	-SEIS
COMP21	INIT=SEIS1+INIT=CSEIS1
COMP22	INIT=SEIS2+INIT=CSEIS2
COMP23	INIT=SEIS3+INIT=CSEIS3
COMP24	INIT=SEIS4+INIT=CSEIS4
COMP25	INIT=SEIS5+INIT=CSEIS5
COMP26	INIT=SEIS6+INIT=CSEIS6
COMP3S	-SEIS
COMP31	INIT=SEIS1+INIT=CSEIS1
COMP32	INIT=SEIS2+INIT=CSEIS2
COMP33	INIT=SEIS3+INIT=CSEIS3
COMP34	INIT=SEIS4+INIT=CSEIS4
COMP35	INIT=SEIS5+INIT=CSEIS5
COMP36	INIT=SEIS6+INIT=CSEIS6

Figure 3.2.1.7-1 SEIS Event Tree Model Macros and Split Fractions

Split Fraction	Split Fraction Assignment Rule
COMP4S	-SEIS
COMP4F	COMP3=F
COMP41	INIT=SEIS1+INIT=CSEIS1
COMP42	INIT=SEIS2+INIT=CSEIS2
COMP43	INIT=SEIS3+INIT=CSEIS3
COMP44	INIT=SEIS4+INIT=CSEIS4
COMP45	INIT=SEIS5+INIT=CSEIS5
COMP46	INIT=SEIS6+INIT=CSEIS6
NPRPS	-FIRE
NPRP1	FACR
NPRPS	1
MCRS	-FIRE
MCR1	FACR+FMCR
MCRS	1

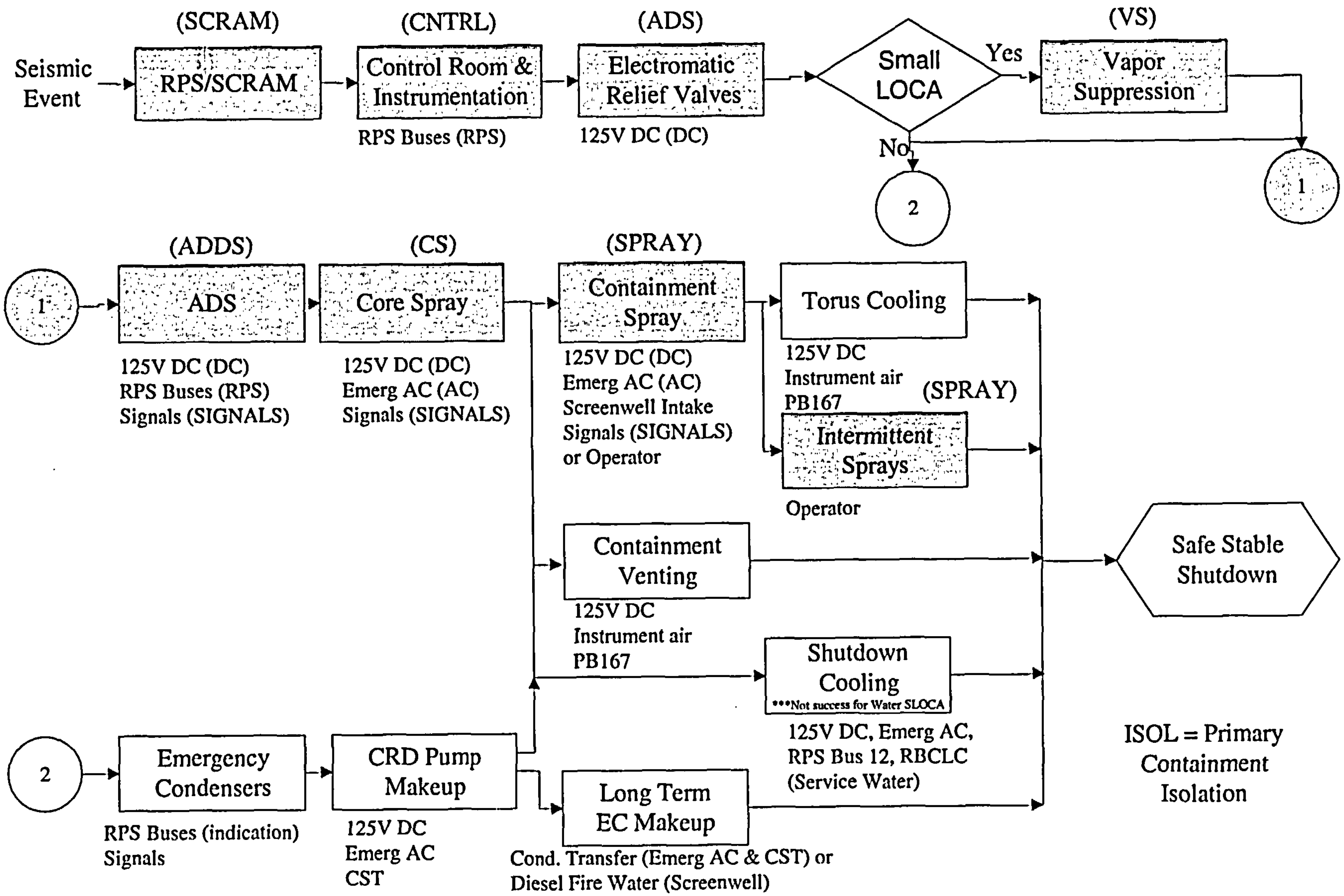


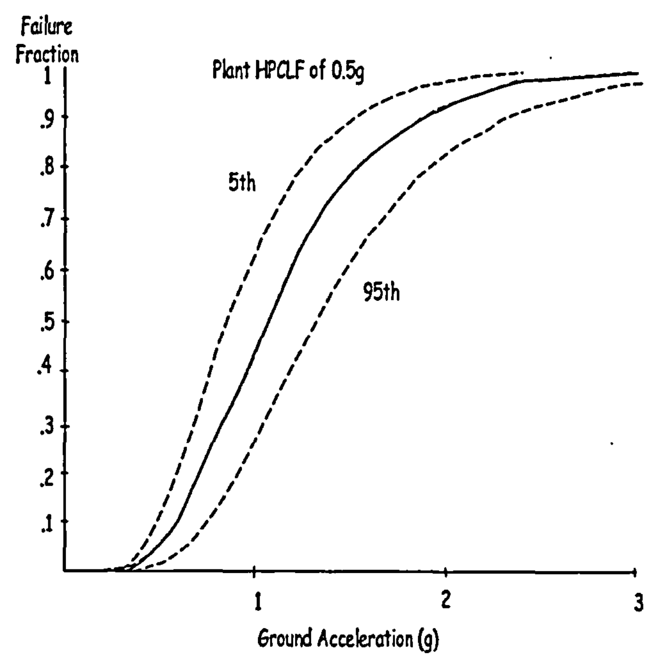
Figure 3.2.1.7-2 Seismic Success Diagram From IPEEE

4.2.30 Seismic - Component Fragilities and Failure Modes

4.2.30.1 Seismic Fragility Analysis

The objective of the fragility evaluation is to estimate the ground acceleration capacity of a given component. This capacity is defined as the peak ground motion acceleration value at which the seismic response of a given component located at a specified point in the structure exceeds the component's resistance capacity, resulting in its failure. The ground acceleration capacity of the component is estimated using information on plant design bases, responses calculated at the design analysis stage, as-built dimensions, and material properties. Because there are many variables in the estimation of this ground acceleration capacity, component fragility is described with uncertainties.

This figure provides an example of how the results can be displayed as a family of fragility curves. The example component is the early large release HCLPF (COMP1).



Three of the curves can be thought of as representing a family of fragility curves where the percentiles indicate the level of confidence that for a given fraction of earthquakes, the component will fail at accelerations greater than indicated by the curve. The center curve is the median (50th percentile) fragility curve. The 5th and 95th percentile curves are also shown reflecting the uncertainty in the median curve. In addition, the mean curve which is calculated with a composite uncertainty (B_C) is shown in the figure as a solid line. The mathematical expressions for developing these curves and their relationships are explained further below. There actually exists a family of curves representing designated cumulative percentiles of confidence. Note that in the above figure, the median seismic capacity of COMP1 corresponds to the failure fraction 0.5 for the median fragility curve.

The above fragility curves can be developed from the best estimate seismic capacity (A_M) and its variabilities (B_U and B_R) using the following equation:

$$A = A_M * e^{(f * Bu + f' * Br)} \qquad (1)$$

where

- A is the ground acceleration corresponding to failure.
- A_M is the best estimate of the median ground acceleration capacity.

- f and f ' are the standard Gaussian random variables. In the above figure, the 5th, 50th, and 95th percentile curves are calculated by setting f ' to -1.645, 0.0, and 1.645, respectively, and varying f from -3.72 (corresponds to 1E-4 failure fraction) to 2.326 (corresponds to 0.99 failure fraction).
- B_U is a logarithmic standard deviation representing uncertainties associated with the lack of knowledge such as analytical modeling assumptions, material strengths, damping, etc which could in many cases be reduced by additional study or testing.
- B_R is a logarithmic standard deviation representing inherent randomness associated with earthquake characteristics such as variabilities in response spectra shapes & amplifications, duration, numbers & phasing of peak excitation cycles, etc which can not be significantly reduced by additional analysis or tests based on current state-of-the-art techniques.

From the above equation, fragility curves and the high confidence of low probability of failure (HCLPF) can be calculated and reported as shown in the above figure.

To calculate the high confidence of low probability of failure (HCLPF), f and f ' are set equal to -1.645 in Equation (1).

Another parameter used is the composite of uncertainty which is related to the above by the following equation:

$$B_C = (B_U^2 + B_R^2)^{1/2} \quad (2)$$

The B_C curve in the above figure is calculated from the following equation:

$$A = A_M * e^{f * Bc} \quad (3)$$

Point estimate quantification of a component failure fraction (probability of the standard normal variate f, P(f)) is calculated from the mean fragility curve, equation (3), as follows:

$$P(f) = \text{Failure Fraction} = P(\ln (A/A_M)/B_C) \quad (4)$$

Both the point estimate and the Monte Carlo options in RISKMAN[I-12] use a piece wise integration algorithm for quantification of the failure fractions. This algorithm splits the range of acceleration values defined for a given initiating event into discrete subintervals, and computes a representative failure fraction for the range by weighting the failure fraction of each of the subintervals by the fraction of the initiating event frequency corresponding to the subintervals. For a single hazard curve and a single fragility curve, the failure fraction for a given initiating event (i.e., over a defined acceleration range) is calculated as follows:

$$FF = \Sigma [f(i)*h(i) / \Sigma h(i)) \quad (5)$$

where

FF = the conditional component failure fraction

f(i) = the conditional component failure fraction calculated at the upper boundary of subinterval "i". For the point estimate quantification option, f(i) is calculated as in equation (4) where f(i) = P(f).
h(i) = the seismic hazard frequency corresponding to the "ith" subinterval. As described in Section 3.2.1, h(i) is calculated by subtracting the exceedance frequency at the upper acceleration boundary of the subinterval from the exceedance frequency corresponding to the lower acceleration bin boundary. The exceedance frequencies used in this calculation must be interpolated from the user supplied points representing the hazard curve. Logarithmic interpolation is used for this calculation.

The point estimate option of RISKMAN does not use the mean hazard curve to compute the failure fractions. Instead, the code generates failure fractions based on each of the input hazard curves (and the mean fragility curve), and calculates the resultant point estimate failure fraction as the weighted average of the results obtained using the individual hazard curves.

The Monte Carlo calculation of failure fractions uses basically the same calculation method described above for the point estimate calculation. The difference is that, for each Monte Carlo trial, RISKMAN randomly chooses one of the user supplied hazard curves, and randomly selects one fragility curve from the family of fragility curves.

4.2.30.2 Summary of Seismic Capability Analysis

The NMP1 plant high confidence low probability of failure (HCLPF), as determined by the seismic margin assessment (SMA)[1-20] and A-46 evaluations, is about 0.3g. A HCLPF of about 0.2g is used in the PRA to represent the likelihood of a small LOCA and failure of instrument air. This is based on judgment since these were not included in the seismic evaluations.

4.2.30.3 Seismic Fragilities Used in PRA

The SMA provides an 84th percentile confidence level HCLPF values with a B_C of 0.46:

$HCLPF_{84}$ = 0.30g for all components in the SMA success path

To convert this SMA CDFM (conservative deterministic failure margin) values to a median fragility for the PRA, the $HCLPF_{84}$ is multiplied by 2.13 to obtain the medium value, A_M. The basis for this conversion is discussed below:

According to EPRI Research Report TR-103595[1-80], "Methodology for Developing Seismic Fragilities," Final Report, June 1994, the median fragility, A_M, can be expressed by

$$A_M = HCLPF_{50} * e^{2.3B_C} \qquad (6)$$

where B_R and B_U have been slightly conservatively combined into B_C. The $HCLPF_{50}$ notation is used to differentiate this HCLPF definition from the one calculated in a SMA using the conservative deterministic margin method (CDFM). In the CDFM method the HCLPF is referred to as the $HCLPF_{84}$ since it is defined to correspond to the ground motion reported at the

84% nonexceedance probability level. This is in contrast to the SRA $HCLPF_{50}$ that corresponds to the ground motion at the median probability level. The relationship between the two HCLPF definitions is given by the following equation:

$$HCLPF_{84} = e^{B_{rs}} * HCLPF_{50} \qquad (7)$$

where B_{RS} is the combined logarithmic standard deviation for the horizontal component response spectrum shape basic variable. It is a SRSS (square root of the sum of the squares) combination of the B_R and B_U values.

Using equations (6) and (7), with $B_C = 0.46$ and $B_{RS} = 0.30$, the median fragility can be converted from the $HCLPF_{84}$ as follows:

$$A_M = 2.13 * HCLPF_{84} \qquad (8)$$

The following table summarizes the seismic fragilities used in the PRA model:

Comp	Description	Fragility				
		$HCLPF_{50}$	B_C	A_M	B_U	B_R
COMP1	Represents early large release	0.42	0.46	1.07	0.44	0.13
COMP2	SMA & A-46 equipment	0.25	0.46	0.64	0.44	0.13
COMP3	Small LOCA & Inst air	0.18	0.46	0.45	0.44	0.13
COMP4	Loss of offsite power	0.12	0.46	0.30	0.44	0.13

The SMA fragility in the above table (COMP2) was still derived conservatively because they have not been scaled to consider differences in peak spectral values relative to the reference PGA (peak ground acceleration). An example of a more realistic development of each fragility is discussed below.

COMP2 (Components Screened at 0.3g HCLPF)

For those components screened out based on EPRI[I-20] Tables 2.3 and 2.4, the CDFM is 1.2g in reference to the peak of the spectra. To scale the peak spectral values back to the reference PGA, the 10000-year 50% spectral shapes from EPRI[I-26] and LLNL[I-27] results in the following table are used:

Frequency (Hz)	NUREG-1488 (g)	EPRI (g)
1	0.023	0.013
2.5	0.068	0.037
5	0.099	0.070
10	0.141	0.107
25	0.136	0.139

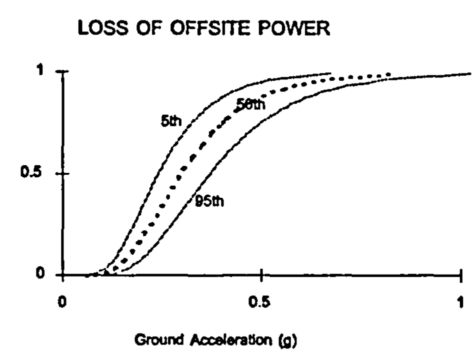
PGA	0.083	0.073

Using the peak spectral value as the basis of comparison, the median fragility for components at the screening value can be estimated as follows:

NUREG $A_M = 2.13 * 1.2 * 0.083/0.141 = 1.5g$
EPRI $A_M = 2.13 * 1.2 * 0.073/0.139 = 1.34g$

COMP2 failure is modeled as causing core damage and represents the SMA conclusion for NMP1 that safety related structures, systems, and components identified in the SMA success diagram have a $HCLPF_{84}$ of 0.3g. Although this assumption is conservative, it does represent the best knowledge available on the fragility of the plant. The results of this analysis provides insights on the potential order of magnitude impact of this assumption. The COMP1 fragility curve is provided in Section 4.2.30.1.

Since offsite power was known to have a relatively low fragility and the purpose of the SMA was to assess the HCLPF of more robust success paths, there was no need to evaluate this system and the numerous systems that depend on offsite power as potential success paths. However, in a PRA it is necessary to model a fragility for offsite power to realistically model station blackout risk. Otherwise, if we assumed loss of offsite power without a fragility, this would result in an unrealistically high core damage frequency from station blackout. The above fragility is similar to that used in the Seabrook Station Seismic PRA[I-79] and other PRAs.



Conditional and unconditional frequency of failure are presented in the tables below for the four fragilities at each discrete hazard initiating event frequency described in Sections 3.1.4 and 5.3.4. The conditional failure fraction is calculated as described in Section 4.2.30.1 and does not include the hazard frequency. The unconditional frequency calculation accounts for the hazard frequency by multiplying the conditional failure fraction times the hazard frequency. The following provides an example unconditional calculation for COMP1:

Unconditional COMP1 at SEIS1 = Conditional COMP1 at SEIS1* SEIS1 Frequency = 2.9E-7 failure fraction (see table below) * 1.46E-2/yr (see Section 5.3.4) = 4.2E-9/yr

Component Conditional Failure Fractions Based on EPRI Hazard							
Component	SEIS1	SEIS2	SEIS3	SEIS4	SEIS5	SEIS6	TOTAL
COMP1	2.9E-7	2.9E-7	5.6E-5	9.2E-3	0.10	0.29	-
COMP2	2.9E-7	2.8E-6	2.2E-3	9.1E-2	0.43	0.70	-
COMP3	2.9E-7	6.6E-5	1.5E-2	0.26	0.71	0.90	-
COMP4	1.1E-6	1.4E-3	8.1E-2	0.57	0.92	0.98	-
Component Unconditional Failure Frequencies Based on EPRI Hazard							
COMP1	4.2E-9	8.2E-11	3.7E-9	5.7E-8	5.1E-8	4.1E-8	1.6E-7
COMP2	4.2E-9	8.1E-10	1.4E-7	5.7E-7	2.2E-7	1.0E-7	1.0E-6
COMP3	4.2E-9	1.9E-8	9.9E-7	1.6E-6	3.6E-7	1.3E-7	3.2E-6
COMP4	1.6E-8	4.0E-7	5.4E-6	3.6E-6	4.7E-7	1.4E-7	9.9E-6

From the above unconditional results, we can see that the frequency of core damage is going to be relatively low in the SPRA. In order for COMP3 (small LOCA and loss of instrument air) failure to cause core damage, core spray & containment spray systems must fail. In order for COMP4 (offsite power) failure to cause core damage, both emergency diesels must fail.

Similar results are provided below for the NUREG hazard:

Component Conditional Failure Fractions Based on NUREG Hazard							
Component	SEISA	SEISB	SEISC	SEISD	SEISE	SEISF	TOTAL
COMP1	1.2E-6	1.5E-4	1.8E-3	8.6E-3	5.8E-2	0.27	-
COMP2	1.2E-4	5.4E-3	3.6E-2	0.10	0.31	0.68	-
COMP3	1.6E-3	3.5E-2	0.15	0.30	0.59	0.89	-
COMP4	1.7E-2	0.17	0.44	0.64	0.86	0.98	
Component Unconditional Failure Frequencies Based on NUREG Hazard							
COMP1	3.2E-10	9.5E-9	9.2E-9	8.4E-8	3.6E-7	4.2E-7	8.8E-7
COMP2	3.2E-8	3.5E-7	1.8E-7	9.8E-7	1.9E-6	1.1E-6	4.5E-6
COMP3	4.3E-7	2.3E-6	7.5E-7	2.9E-6	3.7E-6	1.4E-6	1.1E-5
COMP4	4.5E-6	1.1E-5	2.2E-6	6.2E-6	5.3E-6	1.5E-6	3.0E-5

4.2.30.4 Review Comment

This section contains several parameters that appeared in the original IPEEE and could not be found during the review process for this update. These are:

Values for B_U and B_R
NUREG-1488 "g" values
The equations for median fragilities at the screening value

Better documentation of these is fertile ground for future PRA updates.

5.3.4 Seismic Initiating Events

The key elements of a seismic PRA are similar to other external events in that the hazard (initiating event) must be analyzed and the capability (fragility) of structures, systems, and components relative to the hazard must also be assessed. Also, the internal events PRA is used to model seismic impact (fragility) on structures, systems, and components, and to perform point estimate quantification of seismic PRA sequences.

This section describes the seismic hazards developed by EPRI and NRC. A seismic hazard is required to quantify the unconditional frequency of core damage and radiological releases. The model was quantified utilizing the same RISKMAN[I-12] computer code that contains the PRA model. This code allows seismic hazards (initiating event) and fragilities (failure fractions of equipment in event tree top events) to be integrated into the event tree model and quantification.

Seismic hazard is usually expressed in terms of the frequency distribution of the peak value of a ground-motion parameter (e.g., peak ground acceleration) at the site during a specified time interval. The hazard estimate depends on uncertain estimates of attenuation, upperbound magnitudes, and the geometry of the postulated sources. Such uncertainties are included in the hazard analysis by assigning probabilities to alternative hypotheses about these parameters. A probability distribution for the frequency of occurrence is thereby developed. The annual frequency of exceeding the ground motion parameter, peak ground acceleration, is displayed in Figures 5.3.4-1 and 2 for the Nine Mile Point site.

The frequency of exceeding peak ground accelerations as proposed by EPRI and NRC[I-26 & 27] for the NMP site were used as initiating events to quantify the unconditional frequency of core damage and radiological release. These hazards are presented in Figures 5.3.4-1 and 2. The hazards are discretized and used as initiating events in the SPRA accident sequence analysis. The following summarizes the point estimate initiating events as developed in the PRA:

EPRI HAZARD			NUREG-1488 HAZARD		
Initiator	Acceleration Range (g)	Mean Annual Frequency	Initiator	Acceleration Range (g)	Mean Annual Frequency
SEIS1	0.01-0.05	1.46E-2	SEISA	0.08-0.15	2.62E-4
SEIS2	0.05-0.10	2.87E-4	SEISB	0.15-0.25	6.50E-5
SEIS3	0.10-0.25	6.61E-5	SEISC	0.25-0.31	5.00E-6
SEIS4	0.25-0.51	6.21E-6	SEISD	0.31-0.41	9.70E-6
SEIS5	0.51-0.71	5.10E-7	SEISE	0.41-0.66	6.20E-6
SEIS6	0.71-1.02	1.44E-7	SEISF	0.66-1.02	1.57E-6

The mean annual frequency for each acceleration range (initiator) is calculated by subtracting the upper range from the lower range frequency of exceedance value. For example, SEIS1 is calculated as follows from the Figure 5.3.4-1 mean values:

SEIS1 = (1.5E-2) - (3.6E-4) = 1.46E-2

The EPRI hazard is used in the PRA model quantification. Results with the NUREG hazard are about a factor of 5 higher. The reason for this can be seen by comparing the mean hazard curves. The conclusion that seismic risk is low does not change regardless of which hazard is used.

EPRI and NUREG-1488 Mean Hazard Curves

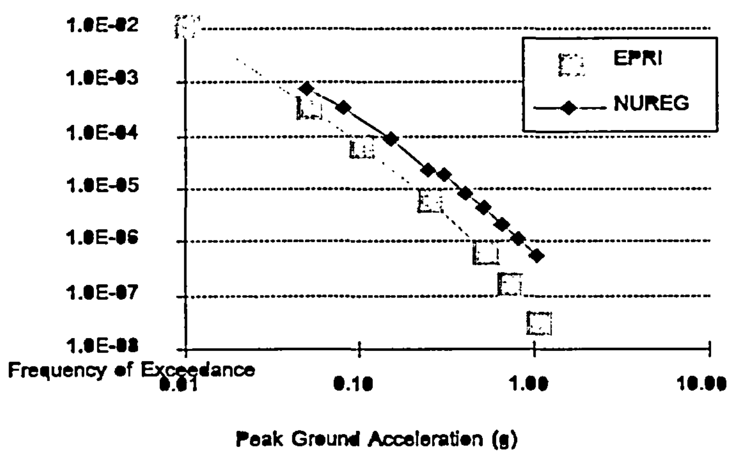
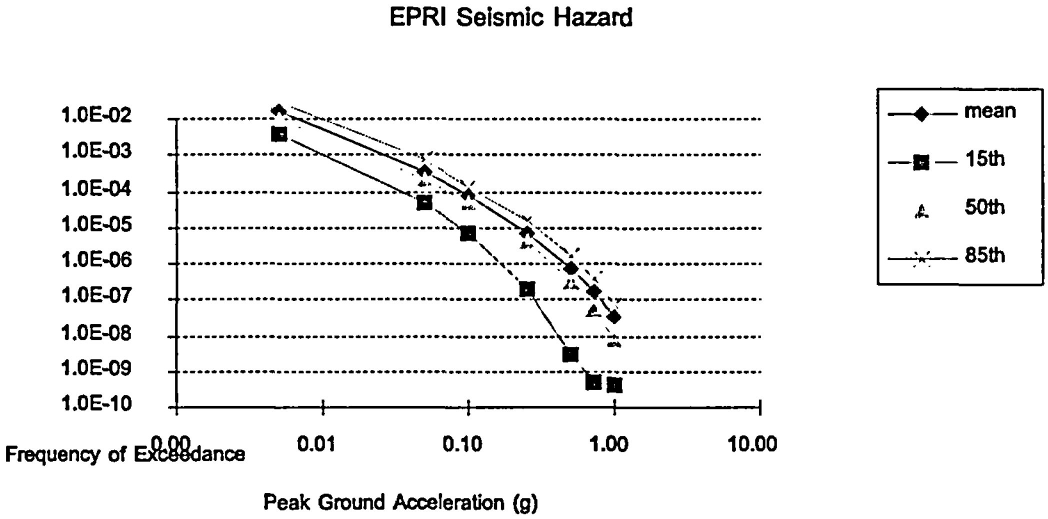
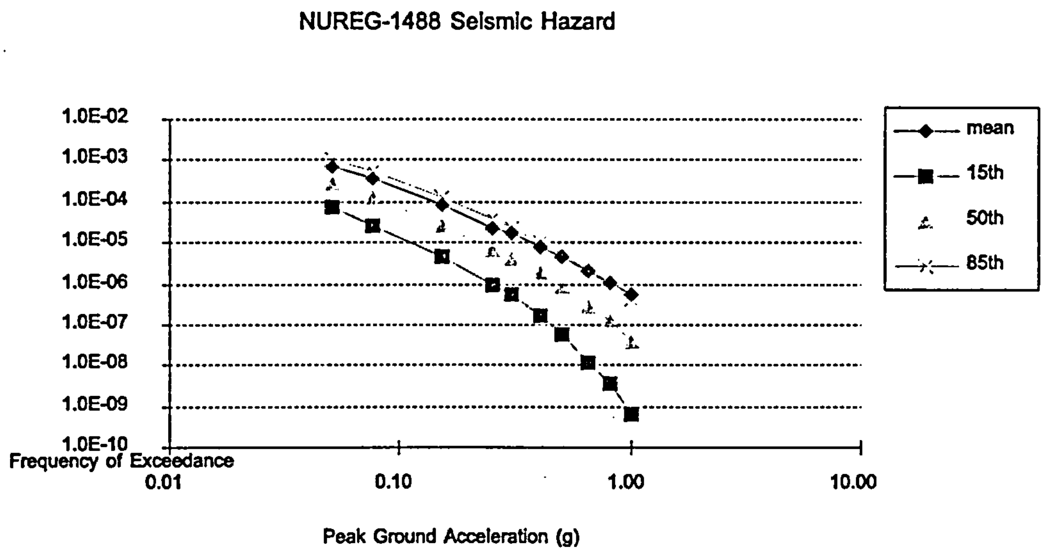


Figure 5.3.4-1



cm/sec2	g(x32.2ft/sec^2)	mean	15th	50th	85th
5	0.01	1.5E-02	3.5E-03	9.8E-03	3.1E-02
50	0.05	3.6E-04	4.7E-05	2.1E-04	7.3E-04
100	0.10	7.3E-05	6.6E-06	5.0E-05	1.3E-04
250	0.25	6.9E-06	1.9E-07	4.0E-06	1.5E-05
500	0.51	6.9E-07	3.1E-09	3.0E-07	1.6E-06
700	0.71	1.8E-07	5.3E-10	5.9E-08	3.7E-07
1000	1.02	3.6E-08	4.0E-10	7.6E-09	7.0E-08

Figure 5.3.4-2



cm/sec2	g(x32.2ft/sec^2)	mean	15th	50th	85th
50	0.05	7.3E-04	7.0E-05	2.7E-04	1.1E-03
75	0.08	3.5E-04	2.7E-05	1.2E-04	5.1E-04
150	0.15	8.8E-05	4.9E-06	2.5E-05	1.3E-04
250	0.25	2.7E-05	1.0E-06	6.7E-06	3.7E-05
300	0.31	1.8E-05	5.3E-07	4.1E-06	2.2E-05
400	0.41	8.3E-06	1.7E-07	1.7E-06	9.8E-06
500	0.51	4.5E-06	5.5E-08	7.8E-07	5.0E-06
650	0.66	2.1E-06	1.2E-08	2.8E-07	2.1E-06
800	0.82	1.1E-06	3.4E-09	1.2E-07	1.0E-06
1000	1.02	5.3E-07	6.2E-10	4.1E-08	4.4E-07

Nine Mile Point Unit 2

Probabilistic Risk Assessment Sections Related to the Seismic Model

- Section 3.2.1.7, Seismic Accident Sequence Model
- Section 4.2.30, Seismic – Component Fragilities
- Section 5.3.4, Seismic Initiating Events

3.2.1.7 Seismic Accident Sequence Model

As shown in Figure 3-1 (Section 3.0), seismic initiating events utilize the SEIS event tree in Figure 3.2.1.7-1 to assess the fragility of the plant. After the SEIS event tree, the model utilizes the same event trees used in the transient analysis (support system event trees in Section 3.2.1.1 and transient event trees in Section 3.2.1.2). Seismic initiating events are described in Sections 3.1.4 and 5.3.4.

The SEIS event tree and overall seismic model development are described in the following subsections.

3.2.1.7.1 SEIS Event Tree Model

The following summarizes the SEIS event tree top events in Figure 3.2.1.7-1. Top events represent system and plant seismic capacities (fragility's) which are described in Section 4.2.30:

COMP1 - Plant HCLPF
This top event represents the screening level used in the seismic analysis. All structures, systems, and components that were screened at a 0.5g high confidence low probability of failure (HCLPF) are represented by this top event. Failure of COMP1 guarantees failure of the plant and core damage (AC and DC power are guaranteed to fail in the SUP1 and SUP3 event trees to ensure core damage occurs). Thus, COMP1 conservatively represents our state of knowledge regarding the plants seismic capability. Containment isolation (top event IS) in the Level II model is also set to guaranteed failure which forces this failure to an large early release (LERF).

COMP2 - High Pressure Nitrogen Bottles
The high pressure nitrogen bottle supplies (top event N1 in the SUP4 event tree) have a fragility less than the screening value in COMP1. Failure of this nitrogen supply (the normal nitrogen supply, N2, depends on normal offsite power, COMP3 described below) prevents long term nitrogen makeup to the SRVs to support low pressure injection. It is assumed that long term makeup is needed to keep SRVs open beyond 24 hours. Failure of COMP2 guarantees failure of top events N1 and N2 in the SUP4 event tree and top vent OD in the TR1 event tree which leads to loss of low pressure injection capability.

COMP3 - Offsite Power Fragility
Offsite power is known to have a relatively low fragility and is used as the fragility for all components not evaluated in the seismic analysis. When COMP3 fails, the following are set to guaranteed failure:

- OG - fails normal AC power and all non safety systems dependent on normal AC power. It also challenges the emergency diesels and requires normally operating pumps to restart.
- ME - does not allow operator recovery of auto ECCS action signals (ME is conservatively assumed to fail for all seismic initiating events even if COMP3 is success).
- TA & TB - the CSTs were not in the analysis scope and are assumed to fail.

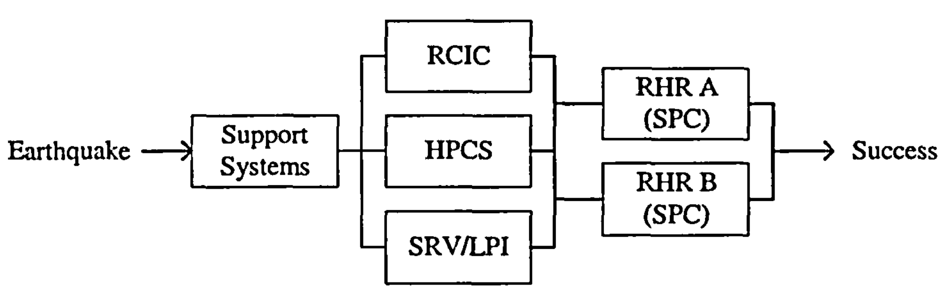
- SW - service water cross-tie as a low pressure injection source requires local operator action and is not allowed.
- FP - fire water cross-tie as a low pressure injection source requires local operator action and is not allowed.
- CV - containment venting depends on air and normal AC and would require local action. Also, the nitrogen & air piping was not evaluated; failing CV ensures that only RHR will be successful in providing containment heat removal, allowing RCIC to be successful from the suppression pool.
- R1 - recovery of offsite power is not allowed even for containment heat removal function. (R1 is assumed to fail for all seismic initiating events even if COMP3 is success).

Top event OD (emergency RPV depressurization to support low pressure injection) in event tree TR1 is assumed to be effected by seismic initiating events. This operator action was identified as important and operator reliability was reduced for seismic initiating events.

3.2.1.7.2 Seismic Model Development

Functional success paths and then progressively more detailed success paths considering frontline and support systems were defined using the PRA model developed for internal initiating events. The components required to support these systems as well as the structures that house these components were identified[P-12]. Also, a relay chatter evaluation[P-13] was performed to identify those relays that could potentially effect the success paths. Structures, systems, and components identified were evaluated for seismic capabilities including seismic qualification, analysis, and test information that would support screening. Calculations were performed as necessary to support screening[P-14 through 18].

Given COMP1 success in the SEIS tree (i.e., no guaranteed core damage), a simplified representation of the success paths in the seismic model is provided here for the case where offsite power is assumed to fail (COMP3 = F).



Consistent with other seismic PRAs, loss of feedwater, main condenser and their support systems is assumed to be incorporated within the loss of offsite power fragility (COMP3). This is a reasonable assumption since offsite power has been assessed to be the weak link and this is based on actual earthquake experience. For the case where none of the fragility's fail (COMP1=S and

COMP2=S and COMP3=S), the seismic initiating events pass through the model assuming that a turbine trip occurs.

All the support systems that are required to maintain reactor inventory control and heat removal are represented by the "Support System" block for simplification. The emergency diesels are the most important components since loss of offsite power is assumed in the above figure. The "HPCS" and "RCIC" blocks represent the high pressure core spray (reactor inventory control) and reactor core isolation cooling (reactor inventory control) systems, respectively. SRVs/LPI represents emergency depressurization with the safety relief valves and low pressure injection with low pressure core spray or low pressure coolant injection (reactor inventory control). As described previously, the COMP2 fragility is assumed to fail the SRVs/LPI success path due to loss of nitrogen to the SRVs beyond 24 hours. This conservatism is discussed below. SPC represents residual heat removal (RHR) "A" or "B" in the suppression pool cooling mode (heat removal).

The reactivity control (RPS/SCRAM) function is not explicitly modeled in the above figure but is included in the PRA model for seismic initiators. The pressure control (SRVs opening in response to transient) and vapor suppression functions are not modeled, consistent with the transient response model. These functions are assessed to be very reliable from both a seismic and non seismic point of view.

<u>Human Response</u>

There are human actions considered relatively important to the accident sequence model and described below:

- Operator actions associated with controlling RCIC and/or HPCS is assumed successful for transients after two cycles from low level start to high level trip and back to low level start again. Given the time it takes for these cycles and the relatively high unavailabilities for these systems, this is considered reasonable for seismic events as well.

- Operator actions to depressurize the reactor, given loss of RCIC and HPCS, is modeled in top event OD. It was assumed for transients that the operators inhibited ADS (automatic depressurization) and then, had to manually open the safety relief valves when level reached top of active fuel. The reliability of ADS and injection systems is sufficiently high such that if the operators failed to disable ADS, core damage frequency would not change significantly. In fact, it is assumed that this treatment is as conservative for seismic events as it is for transients. The operator failure probability used for OD in the seismic model was increased.

- Long term alignment of RHR to suppression pool cooling is explicitly modeled (top event OH in event tree TR2). This was considered to be a very reliable operator action for non seismic events due to the significant time available, limited actions required, and redundant cues available to the operators in the EOPs[I-4]. The total unavailability of RHR (failure of top events LA and LB) with all support systems available has a higher failure probability than OH, which has the equivalent impact as the operator failure. This value is assumed to reasonably envelop operator errors even for seismic events.

- The containment isolation (IS) model includes an operator action to isolate outside motor operated valves, given a station blackout. The probability of failure for non seismic and for seismic is 0.11. The operator failure probability is set to 1.0 for the case where COMP1 fails.

Modeling Assumptions

In addition to assumptions discussed above, the following additional assumptions are included in the seismic model:

- COMP2 fails the low pressure injection success path by assuming that the SRVs will reclose and the RPV repressurize preventing low pressure injection. This occurs more than 24 hours after the initiating event. No credit is allowed for the operators aligning RHR in the shutdown cooling mode of operation which would provide redundancy to COMP2 failure. This was qualitatively considered during the seismic analysis, but was not explicitly included in the scope.

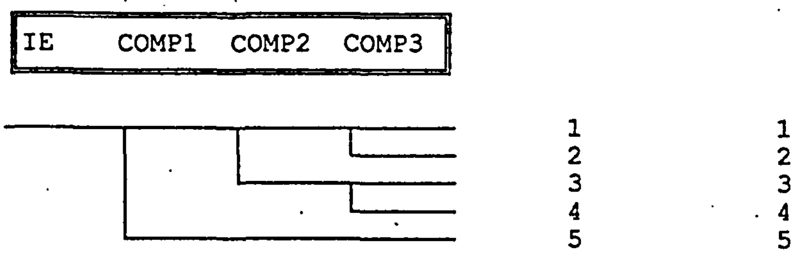
- No credit is given to containment venting which is conservative for the case where only normal AC power is lost.

- Station blackout sequences (failure of COMP3 and A1 and A2) results in early core damage (RCIC & HPCS are assumed to fail due to loss of room cooling). This is conservative since success of RCIC or HPCS could extend the timing to late and allow recovery, yet no credit was taken for this.

- Failure of the plant HCLPF (COMP1) results in early core damage with failed containment (top event IS in Level II model is set to failure). COMP1 represents the conclusion that all safety related equipment in the SMA success path were assessed to have a HCLPF of 0.5g or greater. This modeling is conservative especially for early release. Containment performance evaluations were included in the seismic analysis which considered the primary containment structure, penetrations, piping and valves as well as LOCAs outside containment. The HCLPF for these structures and components is judged to be higher than the 0.5g plant HCLPF value.

- Although functional and system success criteria considered 72 hours as the time needed to respond to seismic events (e.g., CSTs, Nitrogen, DC power) the actual systems analysis quantification in the PRA is the same as for transients (e.g., 24 hours). This is judged to be reasonable given other conservatism's discussed above.

Figure 3.2.1.7-1 Seismic Event Tree (SEIS)



Top Event Designator.....	Top Event Description............................
IE	Initiating Event
COMP1	SMA PLANT HCLPF FRAGILITY
COMP2	HIGH PRESSURE NITROGEN FRAGILITY
COMP3	OFFSITE POWER FRAGILITY

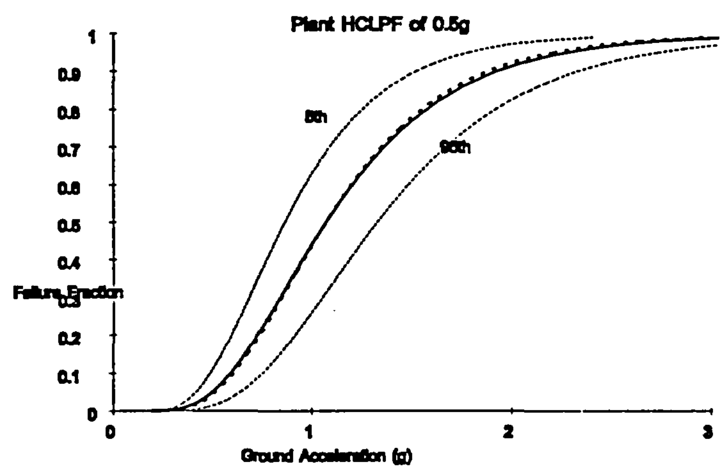
Figure 3.2.1.7-1 Seismic Event Tree (SEIS) Split Fraction Logic

```
SF          Split Fraction Logic...........................................
            SEISI:= INIT=SEIS1+INIT=SEIS2+INIT=SEIS3+INIT=SEIS4+INIT=SEIS5+
                   INIT=SEIS6
            Rule Comment
            ------------
            Level 1 seismic initiating events (mapped through Level 1 model)

            SEISII:= INIT=CSEIS1+INIT=CSEIS2+INIT=CSEIS3+INIT=CSEIS4+
                   INIT=CSEIS5+INIT=CSEIS6
            Rule Comment
            ------------
            Level 2 seismic initiating events (mapped through Level 2 model)

            SEIS:= SEISI + SEISII
            SEIS1:=INIT=SEIS1+INIT=CSEIS1
            SEIS2:=INIT=SEIS2+INIT=CSEIS2
            SEIS3:=INIT=SEIS3+INIT=CSEIS3
            SEIS4:=INIT=SEIS4+INIT=CSEIS4
            SEIS5:=INIT=SEIS5+INIT=CSEIS5
            SEIS6:=INIT=SEIS6+INIT=CSEIS6
COMP1S      -SEIS
            Rule Comment
            ------------
            If no seismic initiator, SEIS event tree is bypassed (see below)

COMP11      SEIS1
COMP12      SEIS2
COMP13      SEIS3
COMP14      SEIS4
COMP15      SEIS5
COMP16      SEIS6
COMP2S      -SEIS
COMP21      SEIS1
COMP22      SEIS2
COMP23      SEIS3
COMP24      SEIS4
COMP25      SEIS5
COMP26      SEIS6
COMP3S      -SEIS
COMP3F      COMP2=F
            Rule Comment
            ------------
            If nitrogen fails (COMP2=F), conservatively assume LOSP (COMP3)

COMP31      SEIS1
COMP32      SEIS2
COMP33      SEIS3
COMP34      SEIS4
COMP35      SEIS5
COMP36      SEIS6
```

4.2.30 Seismic - Component Fragility's and Failure Modes

4.2.30.1 Seismic Fragility Analysis

The objective of the fragility evaluation is to estimate the ground acceleration capacity of a given component. This capacity is defined as the peak ground motion acceleration value at which the seismic response of a given component located at a specified point in the structure exceeds the component's resistance capacity, resulting in its failure. The ground acceleration capacity of the component is estimated using information on plant design bases, responses calculated at the design analysis stage, as-built dimensions, and material properties. Because there are many variables in the estimation of this ground acceleration capacity, component fragility is described with uncertainties.



This figure provides an example of how the results can be displayed as a family of fragility curves. The example component is the plant HCLPF (COMP1) from the seismic analysis.

Three of the curves can be thought of as representing a family of fragility curves where the percentiles indicate the level of confidence that for a given fraction of earthquakes, the component will fail at accelerations greater than indicated by the curve. The center curve is the median (50th percentile) fragility curve. The 5th and 95th percentile curves are also shown reflecting the uncertainty in the median curve. In addition, the mean curve which is calculated with a composite uncertainty (B_C) is shown in the figure as a solid line. The mathematical expressions for developing these curves and their relationships are explained further below. There actually exists a family of curves representing designated cumulative percentiles of confidence. Note that in the above figure, the median seismic capacity of COMP1 corresponds to the failure fraction 0.5 for the median fragility curve.

The above fragility curves can be developed from the best estimate seismic capacity (A_M) and its variability's (B_U and B_R) using the following equation:

$$A = A_M * e^{(f * Bu + f' * Br)} \qquad (1)$$

where

A is the ground acceleration corresponding to failure.

A_M is the best estimate of the median ground acceleration capacity.

f and f ' are the standard Gaussian random variables. In the above figure, the 5th, 50th, and 95th percentile curves are calculated by setting f ' to -1.645, 0.0, and 1.645, respectively, and varying f from -3.72 (corresponds to 1E-4 failure fraction) to 2.326 (corresponds to 0.99 failure fraction).

B_U is a logarithmic standard deviation representing uncertainties associated with the lack of knowledge such as analytical modeling assumptions, material strengths, damping, etc. which could in many cases be reduced by additional study or testing.

B_R is a logarithmic standard deviation representing inherent randomness associated with earthquake characteristics such as variability's in response spectra shapes & amplifications, duration, numbers & phasing of peak excitation cycles, etc. which can not be significantly reduced by additional analysis or tests based on current state-of-the-art techniques.

From the above equation, fragility curves and the high confidence of low probability of failure (HCLPF) can be calculated and reported as shown in the above figure.

To calculate the high confidence of low probability of failure (HCLPF), f and f ' are set equal to -1.645 in Equation (1).

Another parameter used is the composite of uncertainty which is related to the above by the following equation:

$$B_C = (B_U^2 + B_R^2)^{1/2} \qquad (2)$$

The B_C curve in the above figure is calculated from the following equation:

$$A = A_M * e^{f * B_C} \qquad (3)$$

Point estimate quantification of a component failure fraction (probability of the standard normal variate f, P(f)) is calculated from the mean fragility curve, equation (3), as follows:

$$P(f) = \text{Failure Fraction} = P(\ln (A/A_M)/B_C) \qquad (4)$$

Both the point estimate and the Monte Carlo options in RISKMAN use a piece wise integration algorithm for quantification of the failure fractions. This algorithm splits the range of acceleration values defined for a given initiating event into discrete subintervals, and computes a representative failure fraction for the range by weighting the failure fraction of each of the subintervals by the fraction of the initiating event frequency corresponding to the subintervals. For a single hazard curve and a single fragility curve, the failure fraction for a given initiating event (i.e., over a defined acceleration range) is calculated as follows:

$$FF = \Sigma\ [f(i)*h(i) / \Sigma h(i) \qquad (5)$$

where

FF = the conditional component failure fraction

f(i) = the conditional component failure fraction calculated at the upper boundary of subinterval "i". For the point estimate quantification option, f(i) is calculated as in equation (4) where f(i) = P(f).

h(i) = the seismic hazard frequency corresponding to the "ith" subinterval. As described in Section 3.2.1, h(i) is calculated by subtracting the exceedance frequency at the upper acceleration boundary of the subinterval from the exceedance frequency corresponding to the lower acceleration bin boundary. The exceedance frequencies used in this calculation must be interpolated from the user supplied points representing the hazard curve. Logarithmic interpolation is used for this calculation.

The point estimate option of RISKMAN does not use the mean hazard curve to compute the failure fractions. Instead, the code generates failure fractions based on each of the input hazard curves (and the mean fragility curve), and calculates the resultant point estimate failure fraction as the weighted average of the results obtained using the individual hazard curves.

The Monte Carlo calculation of failure fractions uses basically the same calculation method described above for the point estimate calculation. The difference is that, for each Monte Carlo trial, RISKMAN randomly chooses one of the user supplied hazard curves, and randomly selects one fragility curve from the family of fragility curves.

4.2.30.2 Summary of Seismic Capability Analysis

The NMP2 plant high confidence low probability of failure (HCLPF), as determined by the seismic margin assessment (SMA), is greater than 0.5g. With one exception, all structures, systems and components (SSC) identified in the SMA success diagram were evaluated to have a HCLPF value >0.5g. This exception is the non safety related high pressure nitrogen bottle supply to the safety relief valve storage tanks. This nitrogen supply was assumed to be required to keep the safety relief valves open in the long term (>24 hours after the seismic event) after emergency depressurization is required to provide low pressure ECCS makeup to the reactor vessel.

Nitrogen makeup is only required in the long term when, if at all possible, the plant would surely be shutdown in the RHR shutdown cooling mode (SDC) of operation. Although this was not explicitly modeled in the SMA success diagram, RHR in the suppression pool cooling mode (SPC) of operation was modeled which shares many of the components required in the SDC mode. In addition, the SMA success diagram development recognized the SDC mode as a possibility and identified the extra components that would have to be considered. Most of the components are safety related and similar to those evaluated for the SPC mode. Utilizing shutdown cooling does require that an isolation valve in each reactor recirculation loop be closed to force return flow through the jet pumps and into the core. Because these valves are powered by 2NHS-MCC011 and MCC012, which are supplied from offsite power, they are not expected to be operable after a seismic event. However, these MCCs can be fed from a diesel generator via a cross feed arrangement. Shutdown cooling is not needed within the first 24 hours and because it is not needed there is ample time for operator action to realign the electrical buses. In addition, aligning shutdown cooling, without isolating valves in the reactor recirculation loops, may provide adequate heat removal (must maintain pressure below 128 psig), although analyses that demonstrates that natural circulation between the reactor vessel and the cooled recirculation loop can maintain pressure below 128 psig is not available.

4.2.30.3 Seismic Fragility's Used in PRA

The SMA provided the following two 84th percentile confidence level HCLPF values with a B_C of 0.46:

$HCLPF_{84} =$ 0.50g for all safety related components in the SMA success path

$HCLPF_{84} =$ 0.23g for the high pressure nitrogen supply outdoors

To convert these SMA CDFM (conservative deterministic failure margin) values to median fragility's for the PRA, the $HCLPF_{84}$ is multiplied by 2.13 to obtain the medium value, A_M. The basis for this conversion is discussed below:

According to EPRI Research Report TR-103595, "Methodology for Developing Seismic Fragility's," Final Report, June 1994, the median fragility, A_M, can be expressed by

$$A_M = HCLPF_{50} * e^{2.3Bc} \qquad (6)$$

where B_R and B_U have been slightly conservatively combined into B_C. The $HCLPF_{50}$ notation is used to differentiate this HCLPF definition from the one calculated in a SMA using the conservative deterministic margin method (CDFM). In the CDFM method the HCLPF is referred to as the $HCLPF_{84}$ since it is defined to correspond to the ground motion reported at the 84% non exceedance probability level. This is in contract to the SRA $HCLPF_{50}$ that corresponds to the ground motion at the median probability level. The relationship between the two HCLPF definitions is given by the following equation:

$$HCLPF_{84} = e^{Brs} * HCLPF_{50} \qquad (7)$$

where B_{RS} is the combined logarithmic standard deviation for the horizontal component response spectrum shape basic variable. It is a SRSS (square root of the sum of the squares) combination of the B_R and B_U values.

Using equations (6) and (7), with $B_C = 0.46$ and $B_{RS} = 0.30$, the median fragility can be converted from the $HCLPF_{84}$ as follows:

$A_M = 2.13 * HCLPF_{84}$ (8)

The following table summarizes the seismic fragility's used in the PRA model:

Comp	Description	Fragility				
		$HCLPF_{50}$	B_C	A_M	B_U	B_R
COMP1	Represents SMA HCLPF	0.42	0.46	1.07	0.44	0.13
COMP2	High pressure nitrogen	0.18	0.46	0.49	0.44	0.13
COMP3	Loss of offsite power	0.12	0.46	0.30	0.44	0.13

The two SMA fragility's in the above table (COMP1 and COMP2) were still derived conservatively because they have not been scaled to consider differences in peak spectral values relative to the reference PGA (peak ground acceleration). A more realistic development of the each fragility is discussed below and later in this section the significance of this conservatism is discussed:

COMP1 (Components Screened at SMA HCLPF of 0.5g)

For the screened out components in the SMA, most of these items were screened out based on EPRI[11] Tables 2.3 and 2.4, the CDFM is 1.2g in reference to the peak of the spectra. To scale the peak spectral values back to the reference PGA, the 10000-year 50% spectral shapes from EPRI[17] and LLNL[18] results in the following table are used:

Frequency (Hz)	NUREG-1488 (g)	EPRI (g)
1	0.023	0.013
2.5	0.068	0.037
5	0.099	0.070
10	0.141	0.107
25	0.136	0.139
PGA	0.083	0.073

Using the peak spectral value as the basis of comparison, the median fragility for components at the screening value can be estimated as follows:

NUREG $A_M = 2.13 * 1.2 * 0.083/0.141 = 1.5g$
EPRI $A_M = 2.13 * 1.2 * 0.073/0.139 = 1.34g$

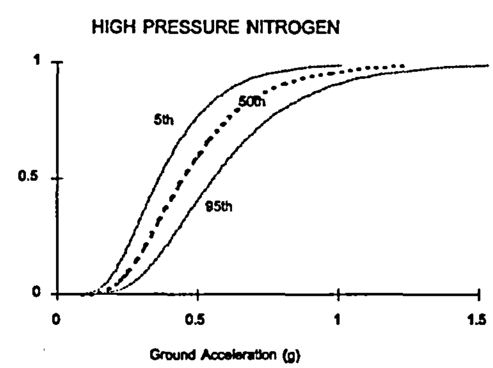
COMP2 (High Pressure Nitrogen, SMA HCLPF of 0.23g)
The HCLPF is governed by the neighboring liquid nitrogen tanks due to seismic interaction. The median fragility can be estimated as follows:

NUREG $A_M = 2.13 * 0.23 * 2.12 * 0.083/0.141 = 0.61g$
EPRI $A_M = 2.13 * 0.23 * 2.12 * 0.073/0.139 = 0.55g$

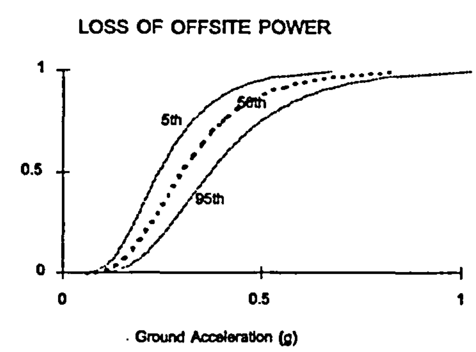
The factor 2.12 is the spectral peak to PGA ratio of the NUREG-0098 50% spectral shape[20].

COMP1 failure is modeled as causing core damage and represents the SMA conclusion for NMP2 that all safety related structures, systems, and components identified in the SMA success diagram have a $HCLPF_{84}$ of 0.5g or greater. Although this assumption is conservative, it does represent the best knowledge available on the fragility of the plant. The results of this analysis provides insights on the potential order of magnitude impact of this assumption. The COMP1 fragility curve is provided in Section 4.2.30.1.

The fragility for high pressure nitrogen (COMP2) is based on the SMA results and is assumed to result in an initiating event even if there is no loss of offsite power. It is conservatively assumed that all nitrogen and instrument air fails resulting in loss of feedwater and the main condenser. In addition, failure of high pressure nitrogen results in failure of low pressure injection (safety relief valves eventually close) if the operators do not have the plant on shutdown cooling in time.



The fragility for loss of the offsite power (COMP3) was not provided in the SMA because the success diagram was developed assuming that offsite power was unavailable (offsite power was recognized to have a relatively low fragility relative to other components). Since offsite power was known to have a relatively low fragility and the purpose of the SMA was to assess the HCLPF of more robust success paths, there was no need to evaluate this system and the numerous systems that depend on offsite power as potential success paths. However, in a PRA it is necessary to model a fragility for offsite power to realistically model station blackout risk. Otherwise, if we assumed loss of offsite power without a fragility, this would result in an unrealistically high core damage frequency from station blackout. The above fragility is similar to that used in Seabrook Station seismic PRA[19] and other PRAs.



Conditional and unconditional frequency of failure are presented in the tables below for the three above fragility's at each discrete hazard initiating event frequency described in Section 3.1.4. The conditional failure fraction is calculated as described in Section 4.2.30.1 and does not include the hazard frequency. The unconditional frequency calculation accounts for the hazard frequency by multiplying the conditional failure fraction times the hazard frequency. The following provides an example unconditional calculation for COMP1:

Unconditional COMP1 at SEIS1 = Conditional COMP1 at SEIS1* SEIS1 Frequency = 2.9E-7 failure fraction (see table below) * 1.46E-2/yr (see Section 3.1.4) = 4.2E-9/yr

Component Conditional Failure Fractions Based on EPRI Hazard							
Component	SEIS1	SEIS2	SEIS3	SEIS4	SEIS5	SEIS6	TOTAL
COMP1	2.9E-7	2.9E-7	5.6E-5	9.2E-3	0.10	0.29	-
COMP2	2.9E-7	6.6E-5	1.5E-2	0.26	0.71	0.90	-
COMP3	1.1E-6	1.4E-3	8.1E-2	0.57	0.92	0.98	-
Component Unconditional Failure Frequencies Based on EPRI Hazard							
COMP1	4.2E-9	8.2E-11	3.7E-9	5.7E-8	5.1E-8	4.1E-8	1.6E-7
COMP2	4.2E-9	1.9E-8	9.9E-7	1.6E-6	3.6E-7	1.3E-7	3.2E-6
COMP3	1.6E-8	4.0E-7	5.4E-6	3.6E-6	4.7E-7	1.4E-7	9.9E-6

From the above unconditional results, we can see that the frequency of core damage is going to be relatively low in the SPRA. In order for COMP2 (nitrogen) failure to cause core damage, HPCS and RCIC must fail and the operators must fail to get to shutdown cooling. In order for COMP3 (offsite power) failure to cause core damage, both emergency diesels must fail.

Similar results are provided below for the NUREG hazard:

Component Conditional Failure Fractions Based on NUREG Hazard							
Component	SEISA	SEISB	SEISC	SEISD	SEISE	SEISF	TOTAL
COMP1	1.2E-6	1.5E-4	1.8E-3	8.6E-3	5.8E-2	0.27	-
COMP2	1.6E-3	3.5E-2	0.15	0.30	0.59	0.89	-
COMP3	1.7E-2	0.17	0.44	0.64	0.86	0.98	-
Component Unconditional Failure Frequencies Based on NUREG Hazard							
COMP1	3.2E-10	9.5E-9	9.2E-9	8.4E-8	3.6E-7	4.2E-7	8.8E-7
COMP2	4.3E-7	2.3E-6	7.5E-7	2.9E-6	3.4E-6	1.4E-6	1.1E-5
COMP3	4.5E-6	1.1E-5	2.2E-6	6.2E-6	5.3E-6	1.5E-6	3.0E-5

5.3.4 Seismic Initiating Events

The key elements of a seismic PRA are similar to other external events in that the hazard (initiating event) must be analyzed and the capability (fragility) of structures, systems, and components relative to the hazard must also be assessed. As described in Section 3.2.1.7, seismic initiators are modeled with internal events in the transient model and the SEIS event tree models seismic impact (fragility) on structures, systems, and components.

This section describes the seismic hazards developed by EPRI and NRC[I-26 & 27]. A seismic hazard is required to quantify the unconditional frequency of core damage and radiological releases. The seismic hazard is usually expressed in terms of the frequency distribution of the peak value of a ground-motion parameter (e.g., peak ground acceleration) at the site during a specified time interval. The hazard estimate depends on uncertain estimates of attenuation, upperbound magnitudes, and the geometry of the postulated sources. Such uncertainties are included in the hazard analysis by assigning probabilities to alternative hypotheses about these parameters. A probability distribution for the frequency of occurrence is thereby developed. The annual frequency of exceeding the ground motion parameter, peak ground acceleration, is displayed in Figures 5.3.4-1 and 2 for the Nine Mile Point site.

The frequency of exceeding peak ground accelerations as proposed by EPRI and NRC[I-26 & 27] for the NMP site are considered as initiating events to quantify the unconditional frequency of core damage and radiological release. These hazards are presented in Figures 5.3.4-1 and 2. The hazards are discretized and used as initiating events in the PRA accident sequence analysis. The following summarizes the point estimate initiating events as developed in the PRA:

EPRI HAZARD			NUREG-1488 HAZARD		
Initiator	Acceleration Range (g)	Mean Annual Frequency	Initiator	Acceleration Range (g)	Mean Annual Frequency
SEIS1	0.01-0.05	1.46E-2	SEISA	0.08-0.15	2.62E-4
SEIS2	0.05-0.10	2.87E-4	SEISB	0.15-0.25	6.50E-5
SEIS3	0.10-0.25	6.61E-5	SEISC	0.25-0.31	5.00E-6
SEIS4	0.25-0.51	6.21E-6	SEISD	0.31-0.41	9.70E-6
SEIS5	0.51-0.71	5.10E-7	SEISE	0.41-0.66	6.20E-6
SEIS6	0.71-1.02	1.44E-7	SEISF	0.66-1.02	1.57E-6

The mean annual frequency for each acceleration range (initiator) is calculated by subtracting the upper range from the lower range frequency of exceedance value. For example, SEIS1 is calculated as follows from the Figure 5.3.4-1 mean values:

SEIS1 = (1.5E-2) - (3.6E-4) = 1.46E-2

The EPRI hazard is used in the RPA model quantification. Results with the NUREG hazard are about a factor of 5 higher. The reason for this can be seen by comparing the mean hazard curves. The conclusion that seismic risk is low for NMP2 does not change regardless of which hazard is used.

EPRI and NUREG-1488 Mean Hazard Curves

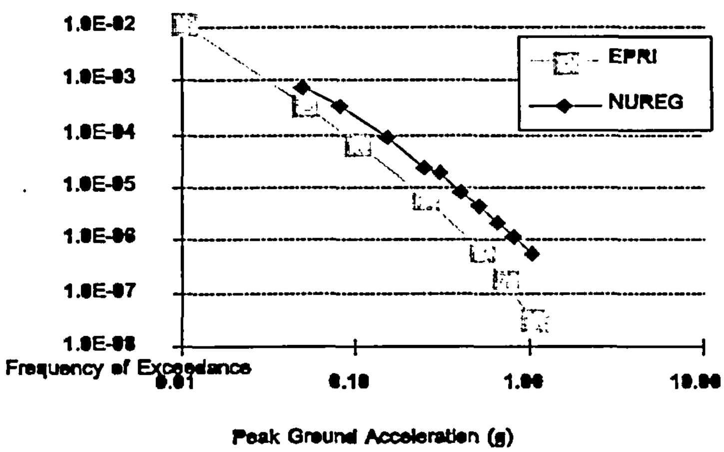
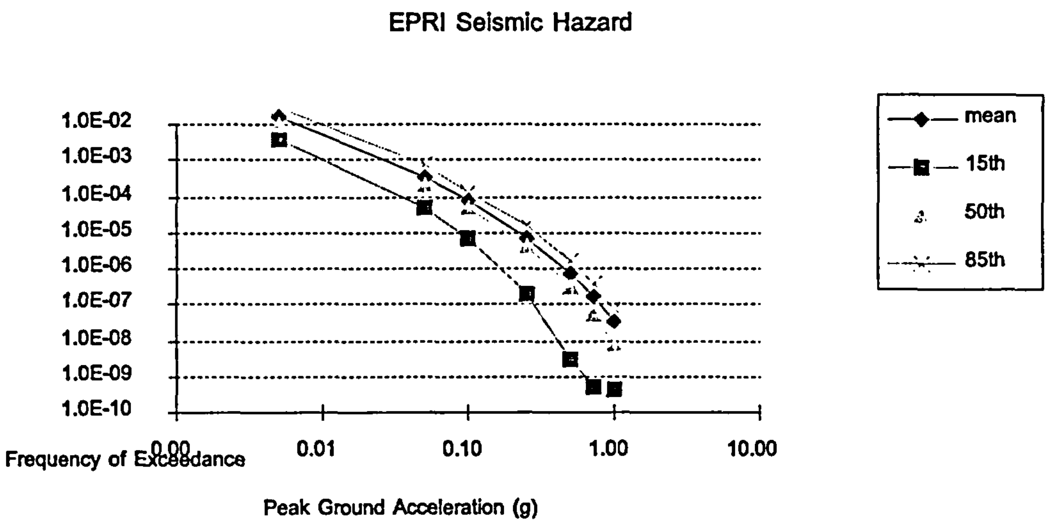
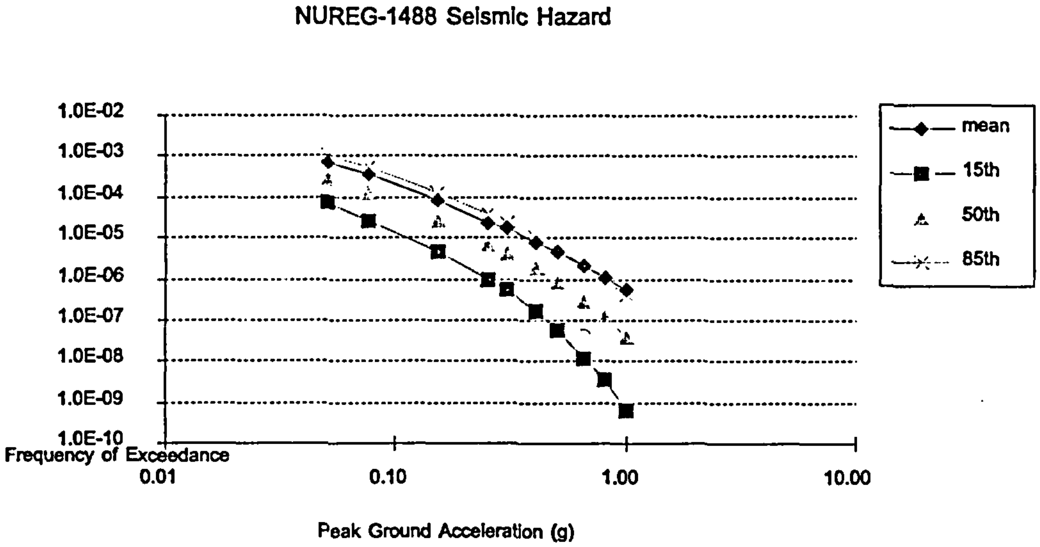


Figure 5.3.4-1



cm/sec2	g(x32.2ft/sec^2)	mean	15th	50th	85th
5	0.01	1.5E-02	3.5E-03	9.8E-03	3.1E-02
50	0.05	3.6E-04	4.7E-05	2.1E-04	7.3E-04
100	0.10	7.3E-05	6.6E-06	5.0E-05	1.3E-04
250	0.25	6.9E-06	1.9E-07	4.0E-06	1.5E-05
500	0.51	6.9E-07	3.1E-09	3.0E-07	1.6E-06
700	0.71	1.8E-07	5.3E-10	5.9E-08	3.7E-07
1000	1.02	3.6E-08	4.0E-10	7.6E-09	7.0E-08

Figure 5.3.4-2



cm/sec2	g(x32.2ft/sec^2)	mean	15th	50th	85th
50	0.05	7.3E-04	7.0E-05	2.7E-04	1.1E-03
75	0.08	3.5E-04	2.7E-05	1.2E-04	5.1E-04
150	0.15	8.8E-05	4.9E-06	2.5E-05	1.3E-04
250	0.25	2.7E-05	1.0E-06	6.7E-06	3.7E-05
300	0.31	1.8E-05	5.3E-07	4.1E-06	2.2E-05
400	0.41	8.3E-06	1.7E-07	1.7E-06	9.8E-06
500	0.51	4.5E-06	5.5E-08	7.8E-07	5.0E-06
650	0.66	2.1E-06	1.2E-08	2.8E-07	2.1E-06
800	0.82	1.1E-06	3.4E-09	1.2E-07	1.0E-06
1000	1.02	5.3E-07	6.2E-10	4.1E-08	4.4E-07

ATTACHMENT 3

List of Regulatory Commitments

The following table identifies those actions committed to by Nine Mile Point Nuclear Station, LLC (NMPNS) in this submittal. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

REGULATORY COMMITMENT	DUE DATE
Provide a final response to the NRC request for additional information regarding justification of the adequacy of the SAMA screening and dispositioning given the fuel enrichment and burnup expected at Nine Mile Point during the renewal period.	January 31, 2005