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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Hope Creek Generating Station
Facility Operating License No. NPF-57
NRC Docket No. 50-354

Subject: Response to NRC Request for Additional Information dated April 20, 2010, related to the Severe Accident Mitigation Alternatives (SAMA) review associated with the Hope Creek Generating Station License Renewal Application

References: 1. Letter from Mr. Charles Eccleston (USNRC) to Mr. Thomas Joyce (PSEG Nuclear, LLC) "REQUEST FOR ADDITIONAL INFORMATION REGARDING SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR HOPE CREEK GENERATING STATION", dated April 20, 2010

2. Letter from Mr. Charles Eccleston (USNRC) to Mr. Thomas Joyce (PSEG Nuclear, LLC) "REVISED REQUEST FOR ADDITIONAL INFORMATION REGARDING SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR HOPE CREEK GENERATING STATION", dated May 20, 2010

In the Reference 1 letter, the staff requested additional information related to the Severe Accident Mitigation Alternatives (SAMA) analysis contained in the Hope Creek Generating Station License Renewal Application (LRA). Reference 2 corrected some minor items related to the initial request. Enclosed are the responses to this request for additional information.

This letter and its enclosure contain no commitments.

If you have any questions, please contact Ed Keating, Senior Environmental Advisor, PSEG Nuclear at 856-339-7902.

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I declare under penalty of perjury that the foregoing is true and correct.

Executed on: 6/1/2010

Sincerely,

Paul J. Davison

Paul J. Davison
Vice President, Operations Support
PSEG Nuclear LLC
Enclosure : Response to Request for Additional Information

cc: S. Collins, Regional Administrator – USNRC Region I (w/o enclosure)
C. Eccleston, Environmental Project Manager, License Renewal – USNRC (w/ enclosure)
R. Ennis, Project Manager – USNRC (w/o enclosure)
NRC Senior Resident Inspector – Salem (w/o enclosure)
P. Mulligan, Manager IV, NJBNE (w/ enclosure)
L. Marabella, Corporate Commitment Tracking Coordinator (w/o enclosure)
Howard Berrick, Salem Commitment Tracking Coordinator (w/ enclosure)
T. Devik, Hope Creek Commitment Tracking Coordinator (w/o enclosure)

ACRONYMS AND ABREVIATIONS		
ACRONYM or ABREVIATION	**RAI # (1st use)**	**DEFINITION**
ABWR	5.n	Advanced Boiling Water Reactor
AC	1.b	alternating current
ACP	1.d, Table 1d-1	AC power
ACRS	1.d, Table 1d-1	Advisory Committee on Reactor Safeguards
ADHR	5.b	alternate decay heat removal
ADS	5.a	automatic depressurization system
AOV	5.i	air operated valve
ASME	1.b	American Society of Mechanical Engineers
AST	4.d	Alternate Source Term
ATWS	1.b	anticipated transient without scram
BE	1.d, Table 1d-1	basic event
BOC	1.b	break outside containment
BWR	1.d, Table 1d-1	boiling water reactor
BWROG	1.d	Boiling Water Reactor Owners' Group
CC	1.d, Table 1d-1	capability category
CCDP	3.a	conditional core damage probability
CCF	1.b	common cause failure
CDC	3.d	certain dangerous cargo
CDF	1.a	core damage frequency
CET	2.a	containment event tree
CFR	3.d	Code of Federal Regulations
CHR	5.b, Table 5b-1	containment heat removal
COTP	3.d	Captain of the Port
CRD	1.d, Table 1d-1	control rod drive
CS	1.d, Table 1d-1	containment spray
CSC	1.b	containment spray cooling
CSS	5.b	core spray system
CV	1.d, Table 1d-1	control valve
DAEC	5.r	Duane Arnold Energy Center

ACRONYMS AND ABREVIATIONS		
ACRONYM or ABREVIATION	**RAI # (1st use)**	**DEFINITION**
DC	1.b	direct current
DE	4.a	Delaware
DG	3.a	diesel generator (same as DGN)
E	4.a	east
EAL	2.a	emergency action level
ECCS	6.i	emergency core cooling system
EDG	1.b	emergency diesel generator
EIA	5.a	emergency instrument air
ENE	4.a	east-north-east
EOP	1.d, Table 1d-1	emergency operating procedure
EPRI	1.b	Electric Power Research Institute
ER	5.j	[license renewal] environmental report
ESE	4.a	east-south-east
ESF	1.d, Table 1d-1	engineered safety features
F&Os	1.d	facts and observations
FERC	3.d	Federal Energy Regulatory Commission
FPIE	1.f	full power, internal events
FPS	1.d, Table 1d-1	fire protection system
F-V	1.e	Fussell-Vesely
FW	1.d, Table 1d-1	feed water
GE	1.d	General Electric Company
GTG	6.c	gas turbine generator
HCGS	1.a	Hope Creek Generating Station
HCLPF	5.j	High Confidence, Low Probability of Failure
HCTL	6.i	heat capacity temperature limit
HEP	1.b	human error probability
HFE	1.d, Table 1d-1	human failure event
HPCI	1.b	high pressure coolant injection
HRA	1.b	human reliability analysis

ACRONYMS AND ABREVIATIONS		
ACRONYM or ABREVIATION	**RAI # (1st use)**	**DEFINITION**
HRS	5.p, Table 5.p-1	hours
HVAC	1.d, Table 1d-1	heating, ventilation and air conditioning
HX	1.b	heat exchanger
IE	1.d, Table 1d-1	initiating event
IMO	3.d	International Maritime Organization
IPE	1.a	individual plant examination
IPEEE	3.a	individual plant examination of external events
K	6.b	thousand
kV	1.d, Table 1d-1	kilovolts
LERF	1.d, Table 1d-1	large, early release fraction [or frequency]
LLC	3.d	Limited Liability Company
LLNL	3.c	Lawrence Livermore National Laboratory
LNG	3.d	liquefied natural gas
LOCA	1.d, Table 1d-1	loss of coolant accident
LOI	3.d	Letter of Intent
LOOP	1.a	loss of offsite power
LOR	3.d	Letter of Recommendation
LPCI	2.b	low pressure coolant injection
LRA	6.a	License Renewal Application
M	6.b	million
m^3	3.d	cubic meters
MAAP	1.d, Table 1d-1	Modular Accident Analysis Program
MACCS2	2.b	MELCOR Accident Consequence Code System for the Calculation of the Health and Economic Consequences of Accidental Atmospheric Radiological Releases
MACR	5.j	maximum averted cost risk
MCCs	1.d, Table 1d-1	motor control centers
MCR	5.l	main control room
MD	4.a	Maryland
MOV	1.d, Table 1d-1	motor operated valve

ACRONYMS AND ABREVIATIONS		
ACRONYM or ABREVIATION	**RAI # (1st use)**	**DEFINITION**
MSIV	5.j	main steam isolation valve
MSPI	1.d, Table 1d-1	mitigating systems performance index
N	4.a	north
NE	4.a	north-east
NEI	1.d	Nuclear Energy Institute
NEMA	5.g	National Electrical Manufacturers Association
NJ	3.d	New Jersey
NNE	4.a	north-north-east
NNW	4.a	north-north-west
NW	4.a	north-west
OECR	4.a	offsite economic cost risk
PA	4.a	Pennsylvania
PACR	5.j	partial averted cost risk
PCIG	1.d, Table 1d-1	primary containment instrument gas
PCS	5.p, Table 5.p-1	primary cooling system
PDR	4.a	population dose risk
PHC	8	Plant Health Committee
PRA	1.a	probabalistic risk assessment
PSA	1.d, Table 1d-1	probabilistic safety assessment
PSF	1.d, Table 1d-1	performance shaping factor
QU	1.d, Table 1d-1	quantification
RACS	1.d, Table 1d-1	reactor auxiliaries cooling system
RAI	2.a	request for additional information
RAW	1.d, Table 1d-1	risk achievement worth
RCIC	1.b	reactor core isolation cooling
RCS	5.p, Table 5.p-1	reactor coolant system
RHR	1.b	residual heat removal
RM	1.f	risk management

ACRONYMS AND ABREVIATIONS		
ACRONYM or ABREVIATION	**RAI # (1st use)**	**DEFINITION**
RPS	5.p, Table 5.p-1	reactor protection system
RPV	1.b	reactor pressure vessel
RRW	5.j	risk reduction worth
RX	6.i	reactor
S	4.a	south
SACS	1.a	safety auxiliaries cooling system
SAG	2.a	severe accident guideline
SAMA	1.a	severe accident mitigation alternative
SAMG	5.d	Severe Accident Management Guidance
SBO	1.b	station blackout
SDC	1.b	shutdown cooling
SE	4.a	south-east
SI	1.d, Table 1d-1	special initiator
SLC	5.r	standby liquid control
SOLAS	3.d	International Convention for the Safety of Life at Sea
SOV	5.o	solenoid-operated valve
SPC	1.b	suppression pool cooling
SRs	1.d	supporting requirements
SRV	2.b	safety relief valve
SSC	1.d, Table 1d-1	structures, systems, and components
SSE	4.a	south-south-east
SSW	1.d, Table 1d-1	standby service water
SSW	4.a	south-south-west
SSWS	1.a	station service water system
SW	5.o	service water
SW	4.a	south-west
SWGR	5. a	switchgear
TAF	5.a	top of active fuel
TDP	5.p, Table 5.p-1	turbine-driven pump
TM	5.p, Table 5.p-1	test and maintenance
TMI	5.i	Three Mile Island Generating Station

ACRONYMS AND ABREVIATIONS		
ACRONYM or ABREVIATION	**RAI # (1st use)**	**DEFINITION**
TSC	1.b	technical support center
URE	1.e	updates requirement evaluation
V AC	1.b	volts alternating current
VDC	1.d, Table 1d-1	volts direct current
W	4.a	west
W/IN	5.p, Table 5.p-1	within
WNW	4.a	west-north-west
WSW	4.a	west-south-west

RESPONSES TO REQUESTS FOR ADDITIONAL INFORMATION (RAIs)

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) used for the Severe Accident Mitigation Alternative (SAMA) analysis:

1.a Provide a brief summary of the most significant changes made to the individual plant examination (IPE) to obtain PRA Model 0.

PSEG Response:

Based on the changes incorporated into the IPE to create PRA Model 0, the CDF decreased from 4.59E-5/yr to 1.29E-5/yr. The significant model changes incorporated into the IPE to create PRA Model 0 included the following:

- Credit is taken for Beyond Design Basis Safety Auxiliaries Cooling System (SACS) and Station Service Water System (SSWS) Success Criteria. When the HCGS IPE was assembled, there had been no analysis that would allow taking credit for the operation of the SACS and SSWS systems beyond their design basis (i.e., success criteria of two out of two pumps per loop). However, as new calculations were performed, it was found that each SSWS loop could perform its function with one out of two pumps operating. It was also found that each SACS loop could perform its function with one pump out of two operating, on the conditions that at least one pump be operating in the opposite SACS loop and that reactor operators are successful in manipulating SACS loads to allow the operation.

- The total CDF decreased from 4.59E-5/yr in the IPE to 1.29E-5/yr in PRA Model 0. The most significant impact the SACS/SSWS success criteria had was on the LOOP initiated core damage sequences. The CDF contribution of LOOP sequences decreased from 3.38E-5/yr to 2.33E-6/yr when credit was given to full capacity operation of the SACS and SSWS. The CDF contribution of loss of decay heat removal sequences was also significantly reduced, decreasing from 5.45E-7/yr to 7.28E-8/yr. However, this represented a very small change in total CDF.

- The SACS and SSWS success criteria assumptions were the major significant changes to the PRA models after the completion of the HCGS IPE to obtain PRA Model 0. Other minor model changes had a negligible impact on CDF.

1.b Sections E.2.1.3, E.2.1.4, E.2.1.5, E.2.1.9 and E.2.1.10 provide very detailed descriptions of the changes made to the various Hope Creek Generating Station (HCGS) revisions. Since Models 1.1, 1.2 and 1.3 were described as minor revisions, identify which of the model changes listed in Sections E.2.1.3 through E.2.1.5 most impacted the change in core damage frequency (CDF) from Model 1.0 to Model 1.3. For Models 108A and 108B, identify the model changes listed in Sections E.2.1.9 and E.2.1.10 that most impacted the change in CDF.

PSEG Response:

Based on the modifications incorporated into PRA Model 1.0 to create PRA Model 1.1, the CDF decreased from 1.80E-5/yr to 1.05E-5/yr. Based on the listing in Section E.2.1.3, the changes with the most impact on CDF included the following:

- NR-SACS-SHED-01 (Failure to Operate with one SACS Pump) - Human error recovery event NR-SACS-SHED-01 is requantified. This operator action involved failure to shed SACS system heat loads in order to reduce the number of SACS pumps and heat exchangers required for successful accident mitigation. Reducing the number of SACS pumps and heat exchangers required for success increases the availability of front line systems (e.g., EDG room cooling and RHR HX cooling).

- NR-RHR-INIT (Failure to Initiate RHR for Suppression Pool Cooling) - Human error recovery event NR-RHR-INIT is requantified. Manual initiation of RHR in the SPC mode is a primary mitigation system for containment heat removal. Operator action NR-RHR-INIT was initially assigned a human error probability of 2.0E-04. The post-accident human error NR-RHR-INIT is also modeled to fail RHR in the Shutdown Cooling mode (SDC) and the Containment Spray mode (CSC). For each of these independent actions (SDC and CSC) the value of 0.1 from the NUREG/CR-1278 Chapter 20 is assigned for each action. This results in a total HEP of 2.0E-04 *0.1 *0.1 = 2.0E-06 to fail all modes of RHR for decay heat removal. To account for potential dependent operator actions for other means of containment heat, operator action NR-RHR-INIT was used to replace operator action NR-VENT-5 (Failure to Vent Containment) in the Containment Venting fault tree logic.

- The Disallow maintenance fault tree was revised to include mutually exclusive events such as two SACS pumps in maintenance or two SSWS pumps in maintenance. Cutsets with multiple trains in maintenance overestimated the CDF because this maintenance combination does not reflect the normal maintenance practices of the plant,. Maintenance configuration is controlled by plant procedures and Technical Specifications.

Based on the changes incorporated to create PRA Model 1.2, the CDF decreased from 1.05E-5/yr to 8.70E-6/yr. Based on the listing in Section E.2.1.4, the changes with the most impact on CDF included the following:

- Enhanced common cause failure (CCF) analysis to include the following:

  - Added basic events for CCF to Start and CCF to Run for combinations of three of four SACS pumps.
  - Added separate CCF events for CCF of the HPCI and RCIC suction strainers and CCF of the RHR and Core Spray suction strainers.
  - Updated various other CCF probabilities due to changes in their independent failure probabilities or due to changes in their associated CCF grouping sizes.

- Eliminated the dependency of Core Spray room cooling on SACS cooling based on a review of room heat up calculations. This model modification decreased CDF because loss of SACS alone does not lead to loss of all RPV makeup.

- Added initiating events, event trees, and system mitigation logic associated with Steam/Water line Break Outside Containment (BOC) and Manual Shutdown events.

- Significantly updated the ATWS sequence and system mitigation logic.

Based on the changes incorporated to create PRA Model 1.3, the CDF decreased from 8.70E-6/yr to 8.66E-6/yr. Based on the listing in Section E.2.1.5, the changes with the most impact on CDF included the following:

- Enhanced SACS success criteria. Specifically, the SACS success criteria was modified to include the following:
  - Failure of one SACS pump and one heat exchanger in one loop, with another SACS pump failure in another loop, with operator failure to re-align the valves.
  - Failure of one SACS pump and one heat exchanger in one loop, with one heat exchanger failure in another loop.

- The SACS initiating event fault tree was modified to be failure of three out of four SACS trains. Similar changes were incorporated for the SACS system mitigation fault tree.

Based on the changes incorporated to create PRA Model 108A, the CDF decreased from 9.76E-6/yr to 7.60E-6/yr. Based on the listing in Section E.2.1.9, the changes with the most impact on CDF included the following:

- Included SACS and SSWS seasonal success criteria. The relaxed requirements for SACS and SSWS cooling to support accident mitigation (e.g., EDG room cooling and RHR HX cooling) during the colder months reduced the CDF.

- Included updated internal flooding model scenarios and flooding initiating event frequencies. The internal flooding PRA was updated and quantified to be consistent with the ASME PRA Standard requirements. The internal flooding initiating event frequencies were developed using the latest EPRI guidance based on industry operating experience. The updated internal flooding model increased the CDF.

- Included portable battery charger to extend DC power supply during Station Blackout scenarios. The HC108A model credited the Technical Support Center (TSC) procedure for aligning the portable battery charger during SBO scenarios. Extending the DC power supply for accident mitigation increased the probability for offsite AC power recovery and reduced the CDF.

- Reassessed the independent human error probabilities (HEPs) using the latest operating crew interviews and the EPRI HRA Calculator. Some HEPs increased and others decreased. The overall impact of the updated independent HEPs reduced the CDF.

- Updated quantitative evaluation of dependent operator actions. Including additional dependent operator action basic events and updating existing joint human error probabilities in the model increased the CDF.

Based on the changes incorporated to create PRA Model 108B, the CDF decreased from 7.60E-6/yr to 5.11E-6/yr. Based on the listing in Section E.2.1.10, the changes with the most impact on CDF included the following:

- Credited procedure change to allow local manipulation of SSWS to SACS heat exchanger valves under LOOP conditions. The ability to locally open the SSWS to SACS heat exchanger valves credits additional success paths for accident mitigation (e.g., EDG room cooling and RHR HX cooling). This procedure change reduced the CDF.

- Updated modeling of 120 VAC inverter room cooling logic to support HPCI and RCIC operation. Updated logic removed conservatism in the model and reduced the CDF.

- Updated the SACS pump Fail to Start and Fail to Run probabilities in the PRA basic event database to be consistent with the Bayesian update values in the PRA documentation. The updated SACS pump data reduced the CDF.

1.c Provide the contribution to the internal event CDF due to anticipated transients without scram (ATWS) and due to station blackout (SBO).

PSEG Response:

For the Hope Creek HC108B model, the ATWS contribution to Level 1 CDF is approximately 1.6E-7/yr, or approximately 3% of the total Level 1 CDF of 5.11E-6/yr (when using a truncation level of 1E-12/yr). The SBO contribution to Level 1 CDF is approximately 6.0E-7/yr, or approximately 12% of the total Level 1 CDF of 5.11E-6/yr.

1.d Provide additional information on the 2008 peer review including the composition of the review team, and the status and impact on the SAMA analysis of the supporting requirements that only met Capability Category I. Describe any other internal and external reviews of the Level 1 (including internal flooding) and Level 2 PRA model, significant review comments and their resolution, and the impact of unresolved comments on the results of the SAMA analysis.

PSEG Response:

The Hope Creek 2008 PRA Peer Review was conducted in accordance with NEI 05-04, "*Process for Performing Follow-on PRA Peer Reviews Using the ASME PRA Standard, Nuclear Energy Institute*". This document defines the review process used in the BWROG industry peer previews. Consistent with NEI 05-04 guidance, the PRA Peer Review team consisted of six (6) members with appropriate and diverse nuclear and PRA experience. The team consisted of one (1) contractor consultant, one (1) GE representative, and four (4) utility PRA representatives. Section 6 of the ASME PRA Standard also provides guidance regarding review team member independence with respect to the PRA under review. The Hope Creek peer review team satisfied the requirements of the ASME PRA Standard and did not include any members who were involved in the performance or preparation of the Hope Creek PRA.

Table 1d-1 provides the following information relative to the Hope Creek 2008 PRA Peer Review:

- A summary of the ASME PRA Standard Supporting Requirements (SRs) that did not meet Capability Category II based on a review of the HC108A PRA model.
- A summary of the PRA Peer Review Finding-level Facts and Observations (F&Os).
- The current status of the identified SRs and Findings relative to the updated HC108B PRA model used as input to the SAMA evaluation.
- The impact of unresolved gaps to the ASME PRA Standard or Findings on the results of the SAMA analysis.

Table 1d-1

OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
IE-A4	SR MET: (CC I)	IE-A4-01 (Finding)	System matrix used to perform IE assessment. System-by-system review was performed and documented in Section 2.4.12 of the IE notebook (HC PSA-001, Rev 1) for evaluation of potential special initiators (SIs) that result in trip or shutdown and degrade a mitigating or support system. Each plant system is listed on a system level basis in Table 2.4-0, but no qualitative review or structured evaluation of impacts is provided as to why a system was or was not screened as a SI. Subsequent evaluation of those systems designated as SI considers the systems on a train basis. For some systems (SSW, SACS, PCIG, some HVAC, etc.) loss of the system or a single loop or train is screened out per criterion (c) in SR IE-C4 although no supporting calculations are referenced showing there is sufficient time to detect and correct the IE conditions before normal plant operation is curtailed. FINDING: No structured evaluation of impacts from individual system or train failures to assess the possibility for an IE. Do not consider buses other than 4kV and 125VDC. No supporting calculations (per IE-C4) to show there is sufficient time to detect and correct potential IE conditions before normal plant operation must be curtailed.	Finding resolved as part of HC108B PRA Update. Capability Category re-assessed as SR MET: (CC II). Therefore, this issue does not impact the ability to perform the SAMA evaluation. The HCGS PRA explicitly models the initiators associated with the following: Loss of SSW %IE-SWS Loss of SACS %IE-SACS Loss of PCIG %IE-IAS The loss of HVAC is explicitly screened out using the screening criterion IE-C4(c). The basis for this is the room heat up calculations provided in the Dependency Notebook which show the times to heat up critical areas is tens of hours and proceduralized guidance is available for alternate cooling. Therefore, the IE-C4(c) screening criteria is met for the HVAC initiator and the other cited initiators are not screened out. For lower voltage buses, MCCs, or panels, these failures are subsumed into the higher voltage or the bus with higher impacts. The special initiator list has been compared with other comparable BWRs, and there is no evidence that any Special Initiators (SI) were missed.

Table 1d-1

OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
IE-A6	SR MET: (CC I)	IE-A6-01 (Finding)	Section 2.1 of the IE notebook (HC PSA-001, Rev 1) notes that interviews were conducted with operations and engineering personnel for precursors, possible plant-unique IEs, and confirmation of the IEs derived from the master logic diagram. However, there is no documentation or detailed reference in the IE notebook on these interviews (persons involved, dates, specific topics discussed, insights, etc.) Appendix I is referenced regarding the precursors, but there are no details on interviews within that appendix. The HRA notebook is also referenced, although Section 2.6 and Appendix F describe only interviews regarding the EOPs, PSFs, training, response time, etc.; where it was noted that the loss of a single 7.2kV bus does not cause a Reactor Scram based on operations interviews (February 2003). Finally, the system notebooks are also mentioned, but a review of the interview documentation in the AC and SSW notebooks shows essentially a duplication of the IE assessment included in the IE notebook. There is no indication of any insights, clarifications, or confirmations provided by the system manager. FINDING: No details are provided regarding interviews conducted with operations and engineering personnel to identify precursors, possible plant-unique IEs, and confirmation of the IEs derived from the master logic diagram.	Finding resolved as part of HC108B PRA Update. Capability Category re-assessed as SR MET: (CC II). Therefore, this issue does not impact the ability to perform the SAMA evaluation. The Initiating Event Notebook includes the results of the systematic process for determining initiating events including the results of both interview processes. Subsequent to the Peer Review in October 2008, the System Managers that were interviewed confirmed the interview results.

Table 1d-1

OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
SC-A6	SR Met: (All)	SC-A6-01 (Finding)	The HCGS PRA basis for success criteria are consistent with the features, procedures, and operating philosophy of the plant, as documented in the Success Criteria notebook (HC PSA-003, Rev 0). However, for the diesel-driven fire-water pump the flow may be assumed too high. The basis for the fire pump as a low pressure source of makeup to the vessel after depressurization is based on flow rate inputs which lack rigor. The flow input to MAAP merely reduces the published pump curve by 20% to account for flow friction losses. The MAAP input also does not correct the pump curve for elevation difference between the fire pump water source and the injection point. Success of the fire pump as a low pressure source of makeup solely depends on its ability to provide adequate makeup. The fire pump flow rate should be based on a flow calculation that considers the piping and fire hose friction and elevation differences. FINDING: The fire pump flow rate should be based on a documented flow calculation that considers the piping and fire hose friction and elevation differences.	Finding resolved as part of HC108B PRA Update. Capability Category remains as SR MET: (All). Therefore, this issue does not impact the ability to perform the SAMA evaluation. A detailed PSEG deterministic calculation for the use of the FPS and a Fire Pumper Truck in tandem was used to confirm the FPS flow rate to the RPV. PSEG has developed a calculation to support operation of the Fire Water system to provide RPV injection. The calculation uses the on-site Fire Pumper Truck and the Diesel Fire Pump – PSEG Calc NC.DE-AP.ZZ-0002(Q), May 2002. The detailed engineering calculation, NC.DE-AP.ZZ-0002 (Q) is used in the MAAP model development.

Table 1d-1

OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
SY-A2	SR Not Met	SY-A2-01 (Suggestion)	The interview seems to be a replication of the previous text of the system notebook. There is no evidence of feedback from the interviewee. The walkdowns are to confirm that the systems analysis is correct. The results of the system walkdowns are merely summed up as being captured in the system evaluation models. This does not meet the intent of the walkdowns.	Suggestion resolved as part of HC108B PRA Update. Capability Category re-assessed as SR MET: (CC II/III). Therefore, this issue does not impact the ability to perform the SAMA evaluation. Subsequent to the Peer Review, the System Managers that were interviewed confirmed the finterview results. The Internal Flood Walkdown Notebook is the most recent documented PRA walkdown and it addresses the spatial influences that may affect systems (primarily flood related).
SY-A6	SR Not Met	SY-A3-01 (Finding)	System components and boundaries are typically not defined in the system notebooks but referred to the Component Data Notebook. This is acceptable for components but the system boundaries should be defined in the system notebook. FINDING - The information provided is incomplete such that the SR is not met.	The Finding remains OPEN. This gap remains as SR Not Met. As noted in the finding, the component information is present in the documentation of the Component Data Notebook. In addition, the system boundary has been drafted for each system notebook but not yet included in the published system notebooks. A review of these system boundaries reveals no impact on the conclusions of the SAMA risk assessment. Therefore, this is a documentation issue not affecting the ability to perform the SAMA risk evaluation.

Table 1d-1

OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
SY-B14	SR Not Met	SY-B14-01 (Finding)	The standard requires that failure of common piping be modeled if the failure affects more than one system. The common piping failure between HPCI/FW/CS and RCIC/FW have not been modeled.	Finding resolved as part of HC108B PRA Update. Capability Category re-assessed as SR MET: (All). Therefore, this issue does not impact the ability to perform the SAMA evaluation. The treatment of the common pipe between the following could influence PRA modeling: - RCIC and FW - HPCI and FW - HPCI and CS For HPCI evaluations, because of the multiple paths into the RPV from HPCI, breaks in the FW or CS pipe do not compromise the ability for HPCI to provide adequate makeup to meet the PRA success criteria. All common valve failures (e.g., MOVs and CVs) between HPCI/CS A and HPCI/FW A are explicitly modeled to fail the common systems. Unisolable breaks outside containment are treated to fail all RPV injection sources in the Reactor Building. Therefore, no additional dependency treatment is needed for those cases. This represents a single example of possible common pipe rupture effects. It does not represent "a systematic failure to address the requirement". This model modification has been evaluated and assessed as a negligible impact on the PRA risk metrics. No other instances of screening common

Table 1d-1

OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
				components for multiple systems are identified.
SY-C2	SR Met: (All)	SY-C2-01 (Finding)	The documentation present in the system notebooks largely addresses the suggested topics from this SR. However, there are several recommendations for improving the documentation: 1. Section 4.4, Dependency Matrix, should have a legend detailing what A and B represent, this was seen in the CRD notebook . 2. Section 2.10 has generic spatial dependencies for CRD. For CS it states "No spatial dependencies other than those imposed by room cooling, internal flooding, and LOCA harsh environment." No details are provided. No details are provided on room location for the CRD and CS notebooks. 3. System walkdown checklists should be used to address the topics in SY-C2. There are system walkdown checklists for the flooding but the questions and focus are not the same as required in SY-C2. 4. If only going to list the basic events in the Quantification Notebook there should be ties in each System notebook going to the respective systems. FINDING -The information provided is incomplete such that the SR is not fully met; the information provided must be more readily	This Finding remains OPEN. Capability Category remains as SR MET: (All). The Supporting Requirement SY-C2 was assessed as SR Met (All) in the peer review assessment, however, a finding was identified. This is a documentation finding not affecting the ability to perform the SAMA risk assessment. Each specific item in the finding was reviewed and would not impact the conclusions of the SAMA risk assessment.

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OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
			defensible & traceable.	
HR-C2	SR MET: (CC I)	HR-C2-01 (Finding)	Tables 4.3-4 and 4.3-5 of the HRA Notebook (HC PSA-004, Rev. 0) present the defined restoration and miscalibration Type A HFEs. The restoration errors include failure to restore a system, train or component to operable status. The calibration errors include miscalibration for signals for equipment realignment or startup (undervoltage, diesel fuel refill, ESF actuation, SACS/RACS temperature control, ventilation control). Additional information provided by PSEG regarding additional errors (e.g., restoration of power supply) referred only to the ACP events in Tables 4.3-4 and 4.3-5. However, these pertain only to bus voltage sensors for undervoltage transfers and restoration of the gas turbine. FINDING: In addition to restoration errors for bus voltage sensors for undervoltage transfers and restoration of the gas turbine, also consider errors for restoration of power supply to specific components and other failure modes identified during the steps described in SRs HR-A1/A2.	Finding resolved as part of HC108B PRA Update. Capability Category re-assessed as SR MET: (CC II/III). Therefore, this issue does not impact the ability to perform the SAMA evaluation. The requested peer review actions were screened from consideration using HR-B1, and therefore, are not applicable for HR-C2.

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OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
HR-D3	SR MET: (CC I)	HR-D3-01 (Finding)	Other than a general statement regarding the high quality of procedures at HCGS, no evidence was seen that the quality of procedures, administrative controls or human-machine interface were evaluated for the pre-initiator HEPs. FINDING: Need discussion showing consideration of the quality of written procedures, administrative controls, and the human-machine interface, and the impact of that quality when evaluating pre-initiator HEPs.	Finding resolved as part of HC108B PRA Update. Capability Category re-assessed as SR MET: (CC II/III). Therefore, this issue does not impact the ability to perform the SAMA evaluation. The quality of the Hope Creek procedures and the human-machine interface were both evaluated as part of the pre-initiator HEP assessment. Both of these aspects were found by the HRA analysts to be above the quality level typically found for BWRs. Sections 3.0.4 and 3.0.13 of the HRA Notebook explicitly address this issue and are used to establish and document the basis for assessing the quality of the PSEG and HCGS procedural guidance.
DA-D1	SR MET: (CC I)	DA-D1-01 (Finding)	The HCGS Component Data Book, Appendix C (HC PSA-010, Rev. 1), documents the plant-specific unavailability/failure probability assessment. A Bayesian update was performed using MSPI data. Generic data were used for SSCs not included in MSPI, which constitute the majority of SSCs. To meet CC II, additional plant specific data for significant basic events need to be assessed.	This Finding remains OPEN. Capability Category remains as SR MET: (CC I). The majority of the high importance systems were updated with recent plant specific data (e.g., EDGs, HPCI, RCIC, RHR, SACS). A review of Hope Creek recent experience indicates no anomalous behavior relative to the data used to characterize the other systems. In addition, based on a review of the HC108B Level 1 and Level 2 cutsets and importance measures, minor changes to the component unavailability and unreliability values would not change the conclusions of the SAMA risk evaluation. Additional plant specific data will be incorporated as part of the next HCGS PRA update.

Table 1d-1

OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
IF-D5	SR MET: (All)	IF-D5-01 (Finding)	The Service Water failure frequencies should match the EPRI failure guideline but they don't. The frequency used is less conservative than that provided in the EPRI guidance. Table G-1 needs to be updated to reflect the correct Service Water (river) rupture frequencies. Note an incorrect rupture frequency was used for the Service Water (river) calculations. This will require the calculations for those sections to be re-performed using the correct EPRI failure frequency. FINDING - This is designated a finding as the wrong frequencies were used for SW failures, which will require correction and update of the calculations.	Finding resolved as part of HC108B PRA Update. Capability Category remains as SR MET: (All). Therefore, this issue does not impact the ability to perform the SAMA evaluation. The PRA Peer Review finding for the pipe rupture frequency was incorporated into the HC108B PRA model. The small change in pipe rupture frequency resulted in a very small change in the CDF and LERF risk metrics. This finding has now been resolved and incorporated in the documentation and the updated PRA. This represents a single example of possible slight deviation from the most current generic data. It does not represent "a systematic failure to address the requirement" as noted in the R.G. 1.200 guidance on the treatment of omissions or oversight. No other deviations were found after a systematic review of the database entries.

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OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	*Peer Review* Capability Assessment	*Applicable* Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
QU-D5a	SR MET: (CC I)	QU-D5a-01 (Finding)	Section 6.0 of the HCGS Quantification notebook (HC PSA-014, Rev. 1) and Section 3 of the PRA Summary notebook (HC PSA-013, Rev. 0) present some of the significant contributors, including initiating events (Tables 6.2-4 and 3.2-4) and accident sequence subclass (Tables 6.2-5 and 3.2-5). Appendix F of the Quantification notebook also provides overall event importance measures. Although they are not categorized by initiating event, equipment failures, common cause failures or operator errors, they do appear to include all significant events. (Per the ASME standard, significant events are those that have a F-V importance greater than 0.005 or RAW importance greater than 2.) Similar information is provided for LERF. Section 4.2 of the Summary notebook provides risk rankings for system trains based on RAW, and Section 4.3 provides the risk important operator actions based on F-V. FINDING: The identification of significant contributors does not include SSCs and operator actions that contribute to initiating event frequencies although those that contribute to event mitigation have been. Also ensure Summary notebook discussion matches results from QU notebook (e.g., risk important operator actions).	Finding resolved as part of HC108B PRA Update. Capability Category re-assessed as SR MET: (CC II/III). Therefore, this is a documentation issue that does not change the conclusions of the SAMA evaluation. SSCs and operator actions involved in event mitigation are included in the importance rankings provided in the appendices. This satisfies the need to identify "significant" events. The Standard allows point estimates for IE values. The support system initiators are evaluated as part of the importance assessment. Based on this importance evaluation, the operator actions contained in these IE can be assessed if needed.

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OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
QU-E4	SR MET: (All)	QU-E4-01 (Finding)	Section 3.4 and Appendix B and C of the PRA Summary notebook (HC PSA-013) provide an evaluation of the important model uncertainties and Section 4.5 and Appendix E provide a set of structured sensitivity evaluations based on these uncertainties. Sensitivity calculations were run, with seven cases being identified as important to model uncertainty. Table 4.5-1 of the PSA-013 contains a summary of sensitivity cases to identify risk metric changes associated with candidate modeling uncertainties. The uncertainties are identified based on generic sources of uncertainty provided in EPRI TR-10009652. However, no additional plant-specific sources of uncertainty are addressed. Initial clarification on sources of uncertainty was provided in a July 27, 2007 NRC memorandum, which specified that at a minimum for a base PRA the analyst must "identify the assumptions related to PRA scope and level of detail, and characterize the sources of model uncertainty and related assumptions, i.e., identify what in the PRA model could be impacted and how". In addition, "While an evaluation of any source of model uncertainty or related assumption is not needed for the base PRA, the various sources of model uncertainty and related assumptions do need to be characterized so that they can be addressed in the context of an application.	This Finding remains OPEN. Capability Category remains as SR MET: (All). The resolution of the treatment of modeling uncertainties in the PRA base model and in applications has NOT yet been resolved. NUREG-1855 has not been issued and the ACRS has not yet agreed with an approach. Plant unique features of Hope Creek that affected the more general uncertainty categories were explicitly captured in the sensitivity evaluations using the Hope Creek model. Additional areas of the Hope Creek PRA were investigated for this potential impact on risk metrics, however, no additional areas rose to the level that they would be considered candidates for modeling uncertainty. The draft EPRI document referred to was not issued during the development of the HCGS PRA and is not considered to apply to the base PRA model and its documentation. In addition, NUREG-1855 requires the requested recommendations for applications, but not as part of the base PRA model and its documentation. The ASME PRA Standard does not require the recommended evaluation for the Base PRA. Therefore, the identification and documentation of modeling uncertainties does not impact the conclusions of the SAMA evaluation.

Table 1d-1

OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
QU-E4 (cont'd)			Therefore, the search for candidates needs to be fairly complete (regardless of capability category), because it is not known, a priori, which of the sources of model uncertainty or related assumptions could affect an application." So excluding plant-specific sources of uncertainty from characterization because they did not "rise to the level that they would be considered candidates for modeling uncertainty" is not appropriate. FINDING - The information provided is incomplete; the most recent industry guidance to address modeling uncertainty in order to meet Cat II for these SRs is not met.	NUREG-1855 publication has resolved the need for additional model uncertainty effort. The HCGS model uncertainty is considered to meet the published NUREG-1855.

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OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
QU-F3	SR MET: (CC I)	QU-F3-01, QUD1a-1 (Finding)	Section 6.0 of the HCGS Quantification notebook (HC PSA-014, Rev. 1) and Section 3 of the PRA Summary notebook (HC PSA-013, Rev. 0) present some of the significant contributors, including initiating events (Tables 6.2-4 and 3.2-4) and accident sequence subclass (Tables 6.2-5 and 3.2-5). Appendix F of the Quantification notebook also provides overall event importance measures, for what appears to include all significant events. Section 6.3 discusses the top 10 accident sequences (68% of the total CDF and at least 2.5% individually) Per the ASME standard, significant accident sequences are those that combine to represent 95% of the CDF or individually represent 1% of the overall CDF. However, there is not a detailed discussion of the significant accident sequences, and the summary table of Accident Classes does not provide a detailed description of significant functional failure groups and does not provide a full, clear picture of the combinations of system or functional failures to which the plant is vulnerable and why they are significant; which is required to distinguish CC II from CCI. FINDING: Provide a detailed discussion of the significant (top 95%) accident sequences or functional failures.	Finding resolved as part of HC108B PRA Update. Capability Category re-assessed as SR MET: (CC II/III). Therefore, this is a documentation issue that does not change the conclusions of the SAMA evaluation. The ASME PRA Standard directions for Capability Category II state: "DOCUMENT the significant contributors ('such as' (1) initiating events, accident sequences, basic events) to CDF in the PRA results summary. PROVIDE a detailed description of significant accident sequences or functional failure groups." The significant contributors listed are examples. The contributing basic events including initiators, HEPs, common cause, and equipment failures are documented in the importance listing of the basic events. The second sentence from this SR requires a detailed description of the significant accident sequences or functional failure groups. The choice for the HCGS PRA is to describe the functional failure groups, i.e., the accident classes. These accident classes (functional failure groups) are described and graphically displayed in the Quantification Notebook and the PRA Summary Notebook.

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OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
QU-F3 (cont'd)				Therefore, the requirements for CC II/III are met. The insight to expand the discussion of accident sequences to include more sequences is a good one and will be pursued as part of a future PRA update. However, this is not considered a failure to meet an ASME Requirement. (1) "such as" means "for example".
QU-F6	SR Not Met	QU-F6-01 (Finding)	Per the 2008 Self Assessment and Roadmap Hope Creek states that they adopted the ASME Definitions for significant BE, cutset, and accident sequences. However, this does not appear to be documented anywhere. The HCGS Quantification notebook (HC PSA-014, Rev. 1) and the PRA Summary notebook (HC PSA-013, Rev. 0) do not appear to include the quantitative definition for significant basic event, significant cutset, and significant accident sequence from Section 2 of the ASME PRA Standard, nor justify an alternative. In addition, the presentation of "significant" results (cutsets, accident sequences, and basis events) clearly does not follow the definitions from the ASME PRA Standard. FINDING: Document in the QU and Summary notebooks the quantitative definitions for significant basic event, significant cutset, and significant accident sequence.	Finding resolved as part of HC108B PRA Update. Capability Category re-assessed as SR MET: (All). Therefore, this is a documentation issue that does not change the conclusions of the SAMA evaluation. The documentation of this definition was added to Section 2 of the HC108B PRA Summary Document.
LE-G1	SR Not Met	LE-G1-01	The Level 2 Analysis Notebook (HC PSA-	Finding resolved as part of HC108B PRA Update.

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OPEN GAPS AND FINDINGS FROM HCGS OCTOBER 2008 PEER REVIEW (HC108A PRA MODEL)

Supporting Requirement	Peer Review Capability Assessment	Applicable Findings & Suggestions	Basis for Assessment	Status and Impact on SAMA Evaluation
		(Finding)	015, Rev. 0) was very detailed, but was not written in a manner conducive to demonstrating the requirements of the standard were met. The documentation roadmap (HC PSA-00, Rev. 0) for the Supporting Requirements for LERF was not helpful in locating information within the Level 2 notebook and in some cases incorrect. FINDING: Organize the Level 2 notebook in a manner conducive to demonstrating the requirements of the standard were met, and consider including references to the PRA standard in the Level 2 Analysis Notebook. For future reviews it would also be helpful (but not required for Capability Category II) provide specific references for the supporting requirements in the PRA documentation roadmap.	Capability Category re-assessed as SR MET: (All). This is a documentation issue that does not change the conclusions of the SAMA evaluation. Additional specificity was added to the Roadmap Document following the Peer Review to further enhance the traceability between the ASME PRA Standard SRs and the documentation.
LE-G6	SR Not Met	QU-F6-01 (Finding)	The HCGS Quantification notebook (HC PSA-014, Rev. 1) and the PRA Summary notebook (HC PSA-013, Rev. 0) do not appear to document the quantitative definition for significant accident. This finding is similar to that identified under QU-F6-01.	Finding resolved as part of HC108B PRA Update. Capability Category re-assessed as SR MET: (All). Therefore, this is a documentation issue that does not change the conclusions of the SAMA evaluation. The documentation of this definition was added to Section 2 of the HC108B PRA Summary Document.

1.e Confirm that any plant modifications or operating changes made since the freeze date for the Model 108B PRA do not have any effect on the conclusions of the SAMA assessment.

PSEG Response:

Hope Creek plant modifications and procedure changes since the freeze date of the HC108B model have been reviewed by Hope Creek Risk Management personnel.

Hope Creek procedures require Risk Management personnel to review plant design changes and procedure changes on a quarterly basis, at a minimum. If a design change or procedure change is judged to impact the PRA model or documentation, then a PRA Updates Requirement Evaluation (URE) is developed by Risk Management personnel.

The plant modifications and procedure changes were reviewed and assessed as to their potential to impact the PRA. No changes were identified that required model updates.

Therefore, the plant modifications and procedure changes do not affect the conclusions of the SAMA assessment.

1.f Briefly describe the overall quality assurance program applicable to the HCGS Level 1 and 2 PRA and its updates.

PSEG Response:

Consistent with most industry PRA programs, the HCGS PRA program is not governed by the Quality Assurance guidelines per 10CFR50, Appendix B. The HCGS Level 1 and 2 PRA quality assurance is dictated by the PSEG Training and Reference Material (T&RM) procedures. The HCGS PRA program is governed by a number of T&RMs to assure quality in the PRA process for the development, documentation, and maintenance of the PRA models. Some significant T&RMs include the following:

- T&RM ER-AA-600 "Risk Management". This procedure specifies the requirements and responsibilities of the Risk Management (RM) Program at PSEG Nuclear facilities. This procedure defines technical activities necessary to comply with governing regulatory requirements as they apply to the PSEG RM Program. This procedure identifies interfaces between the RM Program and other PSEG programs and functions.
- T&RM ER-AA-600-1011 "Risk Management Program". This T&RM provides guidelines for administrative activities of the PSEG Risk Management (RM) Program including the program's mission, values, strategy, success indicators, business practices, staffing, tools, methods and applications, in-house awareness, industry involvement, deliverables, and organization; the division

of roles and responsibilities among the non-site, and site RM personnel; training and qualification of RM personnel; interfaces with regulatory agencies; and interfaces with other PSEG functions and programs.

- T&RM ER-AA-600-1012 "Risk Management Documentation". This T&RM provides guidance for the documentation of RM products, tools, and bases documents. The PSEG quality process includes quality requirements for sign-offs of each product by 1) the preparer, 2) the reviewer, and 3) the approver, as required. Depending on the category of the RM documentation (e.g., supports a License Amendment Request), an independent review may be required for quality assurance.

- T&RM ER-AA-600-1014 "Risk Management Configuration Control". This T&RM provides an acceptable approach for controlling electronic storage of RM products including PRA update information, PRA models and PRA applications.

- T&RM ER-AA-600-1015 "FPIE PRA Model Update". This T&RM establishes responsibilities and general guidelines for updating the full power, internal events (FPIE) Probabilistic Risk Analysis (PRA) Models. This T&RM provides the guidelines for the following:

    - Maintenance of the PRA model and documentation
    - Performing periodic and unscheduled PRA updates
    - Roles and responsibilities during a PRA model update
    - Reviewing the updated PRA model results
    - Implementing the new model for PRA applications after a PRA model update (e.g., high level guidelines to support online maintenance activities).

2. Provide the following information relative to the Level 2 analysis:

2.a Provide a brief history of the development of the current HCGS Level 2 PRA, including for example, its relationship to the IPE level 2 model and the model status relative to the various peer reviews.

PSEG Response:

The HCGS Level 2 IPE analysis was a full Level 2 model with a spectrum of radionuclide release end states (including the Large, Early Release end state). The Level 2 IPE containment analysis model and documentation were sufficiently detailed to address the issues required to meet the intent of the IPE. The Level 2 IPE was developed and quantified using the EVNTRE software code.

For the HC108A PRA update, the Level 2 PRA model and documentation were completely upgraded to use the CAFTA suite of codes and allow dependencies to be transferred from Level 1 to Level 2 using the Boolean Logic models. Some of the Level 2 PRA model attributes include the following:

- The Level 2 Containment Event Tree (CET) sequences and system fault trees were completely revised to be consistent with the state of the technology and to address the requirements of the ASME PRA Standard.
- The Level 2 thermal hydraulic analysis was completely updated using plant specific MAAP runs to support the accident progression and radionuclide release characterization.
- The HC108A Level 2 PRA was a full Level 2 model with a spectrum of radionuclide release end states (e.g., High, Moderate, Low, or Low-Low release magnitudes and Early, Intermediate, or Late release timings). In comparison to the IPE, the HC108A Level 2 model included similar radionuclide release magnitude categories. However, the HC108A Level 2 model included Early, Intermediate, and Late release timings, while the IPE only included Early and Late release timings.
- The Level 2 PRA incorporated the latest EOPs, SAGs, and EALs in support of the Level 2 accident analysis and radionuclide release characterization.
- The Level 2 PRA accounts for the severe accident phenomenological impacts on the plant mitigation capability.
- The Level 1 and Level 2 PRA models were converted to the CAFTA software environment as part of the earlier Model 2003A PRA update.

The HC108A Level 2 PRA model was reviewed as part of the Hope Creek 2008 PRA Peer Review, conducted in accordance with NEI 05-04. The PRA Peer Review identified two (2) supporting requirements (SRs) that were "Not Met" for the HC108A Level 2 PRA. SRs LE-G1 and LE-G6 were documentation issues that were both resolved as part of the subsequent HC108B PRA update used as input for the Hope Creek SAMA analysis. Refer to the response to RAI 1d for additional details regarding the resolution of SR LE-G1 and LE-G6.

The HC108A PRA was updated after completion of the PRA peer review. The changes incorporated as part of the HC108B Level 2 PRA model included the following:

- Updated Level 2 containment isolation fault tree to reduce probability of basic event CIS-LKG-PREXIST (PRE-EXISTING CONT. ISOL. FAILURES) from 5E-3 to 2.7E-3 to be more realistic based on BWR operating experience.
- Updated Level 2 containment isolation fault tree to include logic for failure of the Main Steam Lines or Main Steam Line Drains to isolate.
- Updated Level 2 containment isolation fault tree to include dependence of Reactor Building to torus vacuum breakers to fail open on loss of instrument air.

Decreasing the probability of basic event CIS-LKG-PREXIST decreased the Large Early Release Frequency (LERF) by approximately 1% for the HC108B PRA model. No other Level 2 model changes had a significant impact on the HC108B LERF.

2.b Section E.3.5 states that "representative [Modular Accident Analysis Program (MAAP)] cases for each of the release categories were chosen based on a review of the Level 2 model cutsets and the dominant types of scenarios that contribute to the results." Describe in more detail the process and criteria used to assign the containment event tree end states to release categories and to select the MAAP case to represent each release category.

PSEG Response:

It is noted that the references to tables included in this response use the table numbers as included in the SAMA submittal. The process for characterization of release categories used in the MACCS2 offsite consequence calculations can be summarized as follows:

1. Each of the CET end states is characterized with a radionuclide release magnitude and accident sequence timing. These end states are characterized using the following criteria:

Table E.2-3
RELEASE SEVERITY AND TIMING CLASSIFICATION SCHEME[1]

RELEASE SEVERITY		RELEASE TIMING	
CLASSIFICATION CATEGORY	**CESIUM IODIDE % IN RELEASE**	**CLASSIFICATION CATEGORY**	**TIME OF INITIAL RELEASE[2] RELATIVE TO TIME FOR GENERAL EMERGENCY DECLARATION**
High (H)	Greater than 10	Late (L)	Greater than 24 hours
Medium or Moderate (M)	1 to 10	Intermediate (I)	4 to 24 hours
Low (L)	0.1 to 1	Early (E)	Less than 4 hours
Low-low (LL)	Less than 0.1		
No iodine (OK)	0		

(1) The combinations of severity and timing classification results in one OK release category and 12 other release categories of varying times and magnitudes.

(2) The cue for the General Emergency declaration is taken to be the time when EALs are exceeded. The declaration of the General Emergency initiates the evacuation process.

These radionuclide release end states are summarized in Table E.2-4. They are shown to vary in frequency over a large range, from negligible frequencies to frequencies in the 1E-6/yr range.

Table E.2-4
SUMMARY OF CONTAINMENT EVALUATION

INPUT		OUTPUT	
LEVEL 1 PRA		CET EVALUATION	
CORE DAMAGE FREQUENCY	CHARACTERIZE RELEASE	RELEASE BIN[1]	RELEASE FREQUENCY (PER YEAR)[4]
	Little or No Release	OK	2.12E-06
	Low Public Risk Impact	LL and Late	3.90E-08
		LL and I	2.87E-07
		LL and E	9.30E-08
		L and Late[2]	2.88E-07
		L and I	7.71E-09
		L and E	5.95E-10
	Moderate Public Risk Impact	M and Late[2]	0.00E+00
		M and I	3.17E-07
		M and E	3.57E-07
	High Release	H and Late[2]	1.26E-07
		H and I	1.15E-06
		H and E	4.72E-07[3]

(1) See Table E.2-3 for nomenclature on the release bins.

(2) One of the areas in which PRA tools are somewhat limited is the estimation of recovery or repair during extended times such as 24 hours. Some estimates would indicate that response over such an extended time could be very extensive and highly successful. Therefore, it can be argued that virtually no accidents that take beyond 24 hours to release should be considered to be a significant potential contributor to public risk.

(3) The accident class LERF total of 4.72E-7/yr is slightly lower than the base Level 2 LERF total of 4.76E-7/yr from the single top model. This may be due to the assumption that all Class IV end states were decreased proportionally due to the success branch probability issue. The Level 2 LERF total of 4.76E-7/yr from the single top model is judged to be the appropriate LERF result.

(4) Release frequencies were calculated at a truncation limit of 1E-12/yr.

2. Each CET sequence has an end state. The CET end state assignments are made based upon a MAAP calculation for the accident sequence (or a similar MAAP calculated sequence). Therefore, every CET end state is assigned a radionuclide release category based on the MAAP sequence calculation and the criteria in Table E.2-3. From these Level 2 end states,

additional decisions are made regarding how to incorporate these into the MACCS2 consequence calculation.

3. Given the 13 end states noted in Table E.2-4, there is some additional refinement and source consolidation of the end states recognizing that: (1) the consequence calculations from MACCS2 are somewhat insensitive to minor shifts in the lower consequence categories; (2) some release categories (e.g., M/L, L/I, L/E) have very low frequencies and consequences that are also lower than the more dominant release categories; and, (3) the high consequence categories may be subdivided to refine their risk calculation in MACCS2.

   For example, it is noted that the High/Early release category is expected to be a significant contributor to offsite dose and economic effects. Therefore, it was divided into three separate MACCS2 Source Terms so that these frequencies could be appropriately represented.

   In addition, a simple comparison among the eleven Source Term groups chosen for MACCS2 analysis (see Table E.3-7) show that those for ST1 through ST8 have offsite consequence costs that are all within a factor of approximately 2.5. This is judged not to be a large spread to be represented by eight (8) groups. The remaining three (3) groups have very low offsite economic consequences compared with ST1 through ST8. These also have an OECR that are negligible compared with ST1 through ST8.

4. The criteria for the selection of MAAP cases to be used in the characterization of offsite consequences are as follows:

   o Establish the dominant contributors to each radionuclide release category

   o Find a MAAP case that models the accident progression events, timing, and radionuclide release magnitude for the dominant contributors

   o Use the representative MAAP case for these dominant contributors.

5. The sequences were rank ordered by release category and then the highest frequency sequences and their cutsets were examined to find a representative MAAP sequence that models the core melt progression pathway and timing.

6. The accident sequences for each radionuclide release category are then reviewed to identify the types of sequences that comprise the bin. Based on the sequences and cutsets that appear in the release bin, a MAAP calculation for the most representative set of cutsets and sequences was selected. This is generally the highest consequence MAAP sequence.

7. The results of this assessment are shown in Table E.3-5 which includes the Source Term designation for the MACCS2 input, the associated Level 2 release category, and the selected MAAP case used to characterize the release.

Table E.3-5
REPRESENTATIVE MAAP LEVEL 2 CASE DESCRIPTIONS AND KEY EVENT TIMINGS

SOURCE TERM	RELEASE CATEGORY	MAAP CASE	REPRESENTATIVE CASE DEFINITION	CsI RF(1)	Tcd (HRS)(2)	TVF (HRS)(3)	Tcf (HRS)(4)	Tend (HRS)(5)
ST1	H/E-HP	HC070500 IA-L2-NSPR	Loss of makeup at high pressure. No containment sprays.	0.57	0.60	3.0	3.2	38
ST2	H/E-LP	HC070504 ID-L2-NSPR	Loss of makeup at low pressure. No containment sprays.	0.15	0.47	4.7	4.8	38
ST3	H/E-BOC	HC070524 V-L2-17	Main steam line break outside containment. No injection. Release to environment begins at core damage.	0.69	0.13	6.8	6.9	38
ST4	H/I	HC070509 IIT-L2-WWW	Loss of containment heat removal and subsequent wetwell failure. RCIC and core spray provide injection. SRVs reclose at 50 psid. No containment sprays.	0.30	29.1	38.6	29.8	72
ST5	H/L	HC070515 IIA-L2-WWW	Loss of containment heat removal and subsequent wetwell failure. CRD, RCIC and core spray provide injection. SRVs reclose at 50 psid. No containment sprays.	0.36	35.4	46.4	34.4	84
ST6	M/E	HC070519 IVA-L2-ED-WWA	ATWS event with SLC failure and emergency depressurization. FW, HPCI, and LPCI provide injection until containment failure.	0.070	0.77	5.4	0.58	38

Table E.3-5
REPRESENTATIVE MAAP LEVEL 2 CASE DESCRIPTIONS AND KEY EVENT TIMINGS

SOURCE TERM	RELEASE CATEGORY	MAAP CASE	REPRESENTATIVE CASE DEFINITION	CsI RF(1)	Tcd (HRS)(2)	TVF (HRS)(3)	Tcf (HRS)(4)	Tend (HRS)(5)
ST7	M/I	HC070516 IIA-L2-DW	Loss of containment heat removal and subsequent drywell failure. CRD, RCIC, and core spray provide injection. SRVs reclose at 50 psid. No containment sprays.	0.057	35.4	46.5	34.4	84
ST8	M/L	HC070502 IA-L2-SPRY-A	Loss of makeup at high pressure. Containment sprays fail at containment failure.	0.040	0.58	3.0	21.8	38
ST9	L / E, LL / E, L / I, LL/I	HC070503 IA-L2-SPRY-B	Loss of makeup at high pressure. Containment sprays operate past containment failure.	2.3E-6	0.58	3.0	21.8	38
ST10	L / L, LL / L	HC070505 ID-L2-SPRY	Loss of makeup at low pressure. Containment sprays fail at containment failure.	9.8E-5	0.47	4.8	32.2	38
ST11	Intact	HC070525A OK-L2-A	Loss of makeup at high pressure. Containment sprays and suppression pool cooling operate. Intact containment with technical specification leakage.	1.7E-6	0.58	3.1	NA	38

(1) CsI RF - Cesium Iodide release fraction to the environment

(2) Tcd - Time of core damage (maximum core temperature >1800°F)

(3) TVF - Time of vessel breach

(4) Tcf - Time of containment failure

(5) Tend - Time at end of run

Table E.3-7

MACCS2 BASE CASE MEAN RESULTS

SOURCE TERM	RELEASE CATEGORY	DOSE (P-REM)	OFFSITE ECONOMIC COST ($)	FREQ. (/YR)[1]	DOSE RISK (P-REM/YR)	OECR ($/YR)
ST1	H / E - HP	1.82E+07	1.15E+11	1.830E-07	3.33E+00	2.10E+04
ST2	H / E - LP	1.38E+07	9.63E+10	7.152E-08	9.87E-01	6.89E+03
ST3	H / E - BOC	2.34E+07	1.15E+11	1.302E-07	3.05E+00	1.50E+04
ST4	H / I	8.75E+06	6.41E+10	9.697E-07	8.49E+00	6.22E+04
ST5	H / L	1.10E+07	9.23E+10	8.336E-08	9.17E-01	7.69E+03
ST6	M / E	1.31E+07	9.17E+10	3.477E-07	4.55E+00	3.19E+04
ST7	M / I	6.34E+06	4.73E+10	2.164E-07	1.37E+00	1.02E+04
ST8	M / L	6.38E+06	5.35E+10	0.000E+00	0.00E+00	0.00E+00
ST9	L/E, L/I, LL/E, LL/I	6.44E+03	2.54E+05	2.677E-07	1.72E-03	6.80E-02
ST10	L/L, LL/L	6.87E+05	7.41E+08	2.392E-07	1.64E-01	1.77E+02
ST11	INTACT	1.01E+03	3.63E+04	1.933E-06	1.95E-03	7.02E-02
		FREQUENCY WEIGHTED TOTALS		4.44E-06	2.29E+01	1.55E+05

(1) Release frequencies were calculated at a truncation limit of 5E-11/yr.

2.c Table E.3-5 indicates that for ST5 (loss of containment heat removal with subsequent wetwell failure) the cesium iodine release fraction is 0.36 while for ST7 (loss of containment heat removal with subsequent drywell failure) the release fraction is only 0.057. This appears counterintuitive. In addition, the start time of Plume 1 in Table E.3-6 for ST5 (H/L) and ST7 (M/I) appear to be rounded differently (i.e., 36 h versus 35 h, respectively but should be the same per Table E.3-5). Describe the assumptions and/or phenomena that lead to these results.

PSEG Response:

The representative sequence for ST5 involves an overpressure failure of containment occurring in the wetwell region below the normal water level. The elevation of the break results in a reduction in fission product scrubbing (via the SRV discharge) after the overpressure failure occurs at 34.4 hrs. For the ST7 category, the initial overpressure failure of the drywell does not impact the successful scrubbing of fission products via the SRV discharge path. In both cases, the drywell shell is assumed to fail after vessel breach and provides a direct path for radionuclide transport into the reactor building. A detailed review of the results shows that about 30% of the total CsI inventory is trapped in the suppression pool for ST5 compared to 60% for the ST7 case. Any airborne fission products remaining after drywell shell failure can contribute to the total release.

Differences in the fission product release pathway and scrubbing effectiveness serve to explain the impact on the total release. The sequence of events starts with overpressure of the containment, followed by loss of injection, and eventual core heatup and radionuclide release. The crucial difference between ST5 and ST7 is that suppression pool scrubbing is completely unavailable in ST5 prior to any radionuclide release from the RPV. While ST7 has the benefit of pool scrubbing for the entire duration of the in-vessel core melt progression.

The timing of the initial plume release occurs prior to vessel breach and is impacted by the fission product release pathways described above. These pathways are different and can result in slightly different times for the onset of the release.

3. Provide the following information with regard to the treatment and inclusion of external events in the SAMA analysis:

3.a For both the internal fire and seismic assessments, it is indicated that the 2003 update used the conditional core damage probabilities (CCDPs) based on the 2003 internal event PRA revision. However, on page E-87 it is stated that "the underlying system and plant response models that these analyses rely upon have not been updated since the completion of the [individual plant examination of external events (IPEEE)] in 1997." Clarify the meaning of the latter statement. It would appear that using CCDPs from the 2003 PRA is using updated system models.

PSEG Response:

The CCDPs were based on the 2003A PRA model (August 2003). For the set of failures identified for a given fire or seismic scenario, the 2003A PRA model was quantified to calculate the resulting CCDP that was used to obtain the CDFs for the fire and seismic models.

The statement on page E-87 is also correct and was intended to communicate that the failures caused by a fire or seismic event are still based on the analysis that was performed as part of the IPEEE. For the set of fire and seismic events that were analyzed, the IPEEE contains information about the consequences to the plant systems for those events (e.g., what equipment is failed by a fire in DG Room "C" for a specific fire scenario). This information was retained and used to define the boundary conditions used in the CCDP quantifications.

3.b Describe the meaning of the column headings in Table E.5.4. Clarify whether the values in the column titled "HCGS Seismic IPEEE HEP" are those used in the original seismic IPEEE or the 2003 update. If from the IPEEE, then the modifications described in the final column appear to represent no change from the IPEEE, rather then eliminating "the non-conservative nature of the original seismic analysis" as stated on page E-98.

PSEG Response:

The second bullet on page E-98 is incorrect. As written, it indicates that the original seismic analysis was non-conservative because it had not accounted for the impact of seismic events on the HEPs. However, seismic specific HEPs were developed and incorporated into the IPEEE. This bullet should have indicated that the HEPs in the 2003A PRA model were modified to reflect the seismic HRA that was performed to support the IPEEE.

The modified version of the 2003A PRA model was then used to develop the conditional core damage probabilities (CCDPs). These CCDPs were used in conjunction with the EPRI seismic hazard curves to calculate the seismic core damage frequencies that were used in the HCGS SAMA analysis.

Additional information related to the meaning of the column headings in Table E.5.4 is provided below:

- HCGS PRA Baseline HEP (Basic Event ID): This column provides the HEPs applied to the operator actions in the 2003A internal events PRA model.
- HCGS IPE HEP: This column provides the HEPs applied to the operator actions in the IPE.
- HCGS Seismic IPEEE HEP: This column provides the HEPs applied to the operator actions in the IPEEE seismic analysis. These same HEPs were applied to the 2003A PRA model when it was used to quantify the CCDPs for the 2003 seismic update.
- HEP Modifications in HCGS PRA for Seismic Initiators: This column provides a description of how the IPEEE seismic HEPs were integrated into the 2003A PRA model.

3.c For seismic risk contributor %IE-SET37, the seismic hazard frequency is given on page E-99 as 5.5E-08 per year versus a value of 6.8E-08 per year given in Table 3-8 of the IPEEE. Explain why the values are different.

PSEG Response:

Further review of the documentation supporting the IPEEE indicates that the appropriate value for %IE-SET37 is 6.8E-08/yr, as provided in Table 3-8 of the IPEEE. The value of 5.5E-08/yr, which is provided in Table 3-7 of the IPEEE appears to be an error. The impact of this error on the SAMA analysis has not been analyzed given that the SAMA analysis identification process has been redeveloped using the LLNL seismic hazard curves as part of the response to RAI 5.j.

3.d A liquefied natural gas (LNG) terminal has been approved for construction in Logan Township, New Jersey. Discuss the status of this facility and the potential impact of the transportation of LNG to this facility on HCGS during the license renewal period.

PSEG Response:

On June 20, 2006, the Federal Energy Regulatory Commission (FERC) issued its *Order Granting Authority Under Section 3 of the Natural Gas Act and Issuing Certificate,* which authorized Crown Landing LLC to construct and operate a liquefied natural gas (LNG) terminal in Logan Township, NJ once it satisfies a number of conditions, including acquisition of all required state environmental permits and approvals [*Crown Landing LLC,* 115 FERC 61,348 (2006)]. Ordering Paragraph D of the Order requires Crown Landing to complete construction of, and make available for service, the authorized facilities within three years of the date of the Order – by June 20, 2009. In a letter dated April 17, 2009, the FERC extended the deadline for completing construction and putting the LNG terminal into service until June 20, 2010. In a letter dated March 15, 2010, BP, the owner of Crown Landing LLC, notified the FERC that 100 percent ownership of Crown Landing LLC was transferred to Hess LNG Crown Landing LLC, a Hess LNG affiliate, effective October 28, 2009.

PSEG Nuclear has determined that construction of the Crown Landing LNG terminal had not yet commenced as of March 31, 2010. Furthermore, the Delaware Department of Natural Resources and Environmental Control has denied applications for several required environmental permits and approvals. Hence, although the Crown Landing LNG terminal may ultimately be constructed and placed into service, details concerning LNG deliveries to the terminal are uncertain at this time. Accordingly, any assessment of specific severe accident impacts on Hope Creek during the license renewal period from transportation of LNG to the Crown Landing LNG terminal would be purely speculative. Even so, considering the regulatory process and controls for assuring safety and security that apply to LNG marine traffic and tankers and the safety record of LNG ships, all of which are summarized in the following paragraphs, PSEG believes analysis for Hope Creek of severe accident mitigation alternatives associated with a possible future LNG terminal in Logan Township, NJ, is not currently warranted.

Regulation of LNG Marine Traffic

While the FERC is the federal agency responsible for authorizing construction and operation of onshore LNG facilities, the U.S. Coast Guard (Coast Guard) is the federal agency responsible for issuing Letters of Recommendation (LORs) pursuant to 33 CFR 127.009 regarding the suitability for LNG marine traffic of the waterways on which such facilities will be located. The Coast Guard is also responsible for matters related to navigation safety, vessel engineering and safety standards, and all matters pertaining to the safety of facilities or equipment located in or adjacent to navigable waters up to the last valve immediately before the receiving tanks.

The Coast Guard bases its LOR for a waterway on the following:

- Information in a letter of intent submitted by the owner or operator of the proposed LNG facility, which must provide:
    - o The physical location of the facility
    - o A description of the facility
    - o The LNG vessels' characteristics and the frequency of LNG shipments to or from the facility
    - o Charts showing waterway channels and identifying commercial, industrial, environmentally sensitive, and residential areas in and adjacent to the waterway used by the LNG vessels en route to the facility, within 25 kilometers (15.5 miles) of the facility.

- Density and character of marine traffic in the waterway
- Locks, bridges, or other manmade obstructions in the waterway
- The nature of the following factors adjacent to the facility:
  - Depths of the water
  - Tidal range
  - Protection from high seas
  - Natural hazards, including reefs, rocks, and sandbars
  - Underwater pipelines and cables
  - Distance of berthed vessel from the channel and the width of the channel

The process of preparing the LOR begins when an applicant submits a Letter of Intent (LOI) to the appropriate Captain of the Port (COTP) in accordance with 33 CFR 127.007. If the Coast Guard were to issue a LOR that found the Delaware Bay/River waterway suitable for LNG marine traffic, the arrival, transit, cargo transfer, and departure of LNG ships in the Delaware River would be required to adhere to the procedures of a *LNG Vessel Transit Management Plan,* which would be developed by the Coast Guard Sector Delaware Bay. In addition, the LNG terminal itself would develop Operations and Emergency Manuals in consultation with the Coast Guard. These procedures would be developed to ensure the safety and security of all operations associated with LNG ship transit and unloading. The *LNG Vessel Transit Management Plan* would contain specific requirements for LNG ships, pre-arrival notification, transit through the Delaware Bay and River, the waterfront facility, cargo transfer operations, Coast Guard inspection and monitoring activities, and emergency operations. The Coast Guard Sector Delaware Bay would monitor each LNG ship in accordance with the *LNG Vessel Transit Management Plan.* Some of the anticipated key provisions of an *LNG Vessel Transit Management Plan* are establishment of a moving safety and/or security zone for all inbound and moored LNG ships, use of tugs to assist in the Delaware River and to maneuver the ship into the berth, and requirement that tug(s) remain with the LNG ship while it is moored at the berth.

If the Coast Guard issues a LOR finding the waterway suitable for LNG marine traffic the Coast Guard would promulgate a moving safety zone which would affect other vessels. Pursuant to such a regulation, no vessel would be allowed to enter the safety zone without first obtaining permission from the Coast Guard COTP. The COTP currently places similar restrictions on all vessels transiting the Delaware River and Bay carrying certain dangerous cargoes (CDC) by regulation in 33 CFR 165.510. Presently, the moving safety zone around LNG ships is 1,000 yards ahead and behind, and 500 yards on either side of the vessel. Minimum visibility conditions would have to be satisfied before the LNG ship would be allowed to proceed inbound from the ocean, ensuring that the Coast Guard could adequately monitor the safety zone. Currently there is a 100 yard security zone for moored or anchored vessels carrying dangerous cargo. The regulation provides the Coast Guard and local law enforcement personnel with the authority to implement additional control measures within the zone, such as check points, should such action be warranted based on a specific threat or credible intelligence. Additionally, it is important to note that the requirements of 33 CFR 165.150 were designed to apply to any CDC vessel transiting the Delaware Bay and River, and does give consideration to security measures that may be applied to mitigate risk.

Regulation of Ship Design and Construction

Besides complying with the Coast Guard's controls on LNG marine traffic, LNG ships used to import LNG to the United States would be constructed and operated in accordance with the International Maritime Organization (IMO) Code for the Construction and Equipments of Ships Carrying Liquefied Gases in Bulk, the International Convention for the Safety of Life at Sea (SOLAS), and 46 CFR Part 154, which contain the U.S. safety standards for vessels carrying bulk liquefied natural gas. Foreign flag LNG ships are required to possess a valid IMO Certificate of Fitness and a Coast Guard Certificate of Compliance. In 1993, amendments to the IMO's Code for the Construction and Equipments of Ships Carrying Dangerous Chemicals in Bulk required all tankers to have monitoring equipment with an alarm facility which is activated by detection of over-pressure or under-pressure conditions within a cargo tank. In addition, the cargo tanks are heavily instrumented, with gas detection equipment in the hold and inter-barrier spaces, temperature sensors, and pressure gauges. Fire protection must include the following systems:

- A water spray (deluge) system that covers the accommodation house control room and all main cargo valves;
- A traditional firewater system that provides water to fire monitors on deck and to fire stations found throughout the ship;
- A dry chemical fire extinguishing system for hydrocarbon fires; and
- A carbon dioxide system for protecting machinery, including the ballast pump room, emergency generators, and compressors.

As a result of the terrorist acts that occurred on September 11, 2001, the IMO agreed to new amendments to the 1974 SOLAS addressing port facility and ship security. As a result, the International Ship and Port Facility Security Code was adopted in 2003 by the IMO. This code requires both ships and ports to conduct vulnerability assessments and to develop security plans. The purpose of the code is to prevent and suppress terrorism against ships, improve security aboard ships and ashore, and reduce the risk to passengers, crew, and port personnel on board ships and in port areas, for vessels and cargoes. All LNG ships, as well as other cargo vessels 300 gross tons and larger and ports servicing those regulated vessels, must adhere to these IMO and SOLAS standards. Some of the IMO requirements are as follows:

- Ships must develop security plans and have a Ship Security Officer
- Ships must be provided with a ship security alert system. These alarms transmit ship-to-shore security alerts to a competent authority designated by the Administration, which may include the company, identifying the ship, its location and indicating that the security of the ship is under threat or it has been compromised
- Ships must have a comprehensive security plan for international port facilities, focusing on areas having direct contact with ships
- Ships may have certain equipment onboard to help maintain or enhance the physical security of the ship.

LNG Ship Safety

Since 1959, LNG has been transported by ship without a major release of cargo or a major accident involving an LNG ship. Starting in 1971, LNG began arriving at the Distrigas facility in Everett, Massachusetts. As of early 2006, more than 680 cargoes, with volumes ranging from 60,000 to 125,000 m^3, have been delivered into the Port of Boston without incident. During 2005, an estimated total of 631 billion cubic feet (241 cargoes) of LNG was imported into the United States. For 35 years, LNG shipping operations have been safely conducted in the United States. [Federal Energy Regulatory Commission, 2006. *Final Environmental Impact Statement,* Crown Landing LNG and Logan Lateral Projects. Docket Nos. CP04-411-000 and CP04-416-000. FERC/EIS – 0179. April.]

The world's LNG ship fleet currently exceeds 173 carriers. Over the last 45 years, LNG ships have made over 44,000 voyages. Currently, all of the ships in the LNG fleet operate under a foreign flag with foreign crews. A foreign flag ship must have a Certificate of Compliance inspection by the Coast Guard to ensure compliance with international safety standards. [Federal Energy Regulatory Commission, 2006. *Final Environmental Impact Statement,* Crown Landing LNG and Logan Lateral Projects. Docket Nos. CP04-411-000 and CP04-416-000. FERC/EIS – 0179. April.]

Conclusion

Based on (1) the regulatory process and controls for assuring the safety and security of LNG ships, (2) the safety record of LNG ships, and (3) the uncertainty of the Crown Landing LNG terminal project, PSEG submits that analysis for Hope Creek of severe accident mitigation alternatives associated with a possible future LNG terminal in Logan Township, NJ, is not currently warranted.

4. Provide the following information concerning the MACCS2 analysis:

4.a Section E.3.2 states that SECPOP2000 census data from 1990 to 2000 were used to determine the population growth factor, and that the population growth was averaged over each ring and applied uniformly to all sectors within each ring. Using an average growth over a ring mixes growth rates from significantly different regions. For example; portions of Kent County, Delaware; Chester County, Pennsylvania; and Cumberland County, New Jersey will lie on similar rings. Between years 2000 and 2003, they had population growths of 6.1 percent, 5.5 percent and 2.0 percent, respectively (http://www.epodunk.com/top10/countyPop/coPop8.html, http://www.epodunk.com/top10/countyPop/coPop39.html, and http://www.epodunk.com/top10/countyPop/coPop31.html). Provide an assessment of the potential impact on population dose risk (PDR) and offsite economic cost risk (OECR) if a wind-direction-weighted growth estimate for each sector were used.

<u>PSEG Response:</u>

Population projection necessitates a range of approximations. In general, population growth rates are found to differ substantially based on radial distance from the site and it is desirous to include these radial variations. Angular variations in growth rates are generally viewed as being of secondary importance due to lateral plume dispersion as a function of distance and the use of mean values in the SAMA analysis; however, it can be envisioned that angular population growth rate variations could become important if combined with strong wind direction variations.

Significant radial growth rate differences for the 1990 to 2000 period are evident in the Hope Creek radial growth rates for each ring around the site, varying from 38% per ten years for the 4-to-5 mile ring to 1% per ten years at the 30-to-40 mile ring. "Whole County" based population growth rates do not address population growth rate differences within a county and often do not capture the radial variation in relationship to the site (dependent upon the size and orientation of the county relative to the site). For example, Cumberland County, NJ situated due east of the site begins approximately 7 miles from the site and extends to approximately 35 miles from the site. Growth rate variations used in the SAMA analysis varied between 17% (5-to-10 mile ring) and 1% (30-to-40 mile ring) for this county. Use of a single county growth rate value for Cumberland County would not capture this radial variation. Similarly, for Kent County, DE, located approximately due south of the site (extending from an approximate radial distance of 8 miles to 45 miles) the SAMA analysis growth rates varied from 1% to 17%. For Chester County, PA, (which extends approximately 23 miles from the site to outside the 50-mile region), the SAMA analysis growth rates varied from 1% to 9% dependent upon the distance from the site.

As part of the MACCS2 processing of meteorological data, wind direction is tabulated and binned for the 8760 hours of annual data according to 16 directional sectors. For the Hope Creek SAMA base case year of meteorology (2004), the wind direction frequency is found to be relatively even for the 16 sectors, as shown in the following table:

Wind Bin (Sector)	Wind Direction (Blowing Towards)	Frequency (/yr)	Downwind Counties
1	N	0.056	NJ – Salem, Gloucester PA – Delaware, Chester, Philadelphia, Montgomery DE – New Castle
2	NNE	0.059	NJ – Salem, Gloucester, Camden, Burlington PA – Philadelphia, Montgomery
3	NE	0.062	NJ – Salem, Cumberland, Gloucester, Camden, Atlantic, Burlington
4	ENE	0.057	NJ – Salem, Cumberland, Gloucester, Atlantic, Burlington
5	E	0.058	NJ – Salem, Cumberland, Atlantic, Cape May
6	ESE	0.067	NJ – Salem, Cumberland, Cape May
7	SE	0.101	Primarily Delaware Bay NJ – Salem, Cape May DE – Kent, Sussex
8	SSE	0.069	NJ – Salem DE – New Castle, Kent, Sussex
9	S	0.066	NJ – Salem DE – New Castle, Kent, Sussex MD – Caroline, Talbot
10	SSW	0.069	NJ – Salem DE – New Castle, Kent MD – Kent, Queen Anne's, Caroline, Talbot
11	SW	0.067	NJ – Salem DE – New Castle MD – Kent, Cecil, Queen Anne's, Baltimore
12	WSW	0.046	NJ – Salem DE – New Castle MD – Kent, Cecil, Hartford, Baltimore
13	W	0.027	NJ – Salem DE – New Castle MD – Cecil, Hartford PA – York, Lancaster
14	WNW	0.028	NJ – Salem DE – New Castle MD – Cecil PA – Chester, Lancaster, York
15	NW	0.099	NJ – Salem DE – New Castle PA – Chester, Lancaster
16	NNW	0.067	NJ – Salem DE – New Castle PA – Chester, Delaware, Montgomery
Total	--	1.00	--
Average	--	0.063	--

Per the table above, the highest wind frequency (0.101, Southeast) is primarily associated with the Delaware Bay. This sector has negligible population. The second highest wind frequency (0.099) is in the opposite direction (i.e., Northwest) and includes a significant portion of Chester County, PA. One of the lowest frequencies (i.e., 0.028, WNW) is adjacent and contains portions of southern Chester County. The other adjacent sector (NNW) also contains significant portions of Chester County and has a frequency (0.067) close to the average (0.063). It is noted that for Chester County which is situated more than 20 miles from the site, a postulated release is expected to have dispersed laterally across several sectors by the time such a radial distance is achieved. If the frequencies of the three primary sectors for Chester County (i.e., WNW, NW, and NNW) are averaged, a frequency of 0.065 is determined ((0.028+0.099+0.067)/3=0.0647), which is very close to the average sector value of 0.063.

Based on the relatively even wind direction profile surrounding the site, the propensity for lateral release dispersion into adjacent sectors as a function of radial distance, and the use of mean values in the SAMA analysis, it is judged that the impacts associated angular growth rates are minimal and bounded by the 30% population increase sensitivity case that was performed as part of the SAMA analysis.

4.b Section E.3.2 does not discuss transient population. Clarify whether transient population was considered in the analysis. If a transient population was not considered, provide a justification/rationale for not including it.

PSEG Response:

Transient population was included for the 10-mile region around the site based on data in the site evacuation time estimate study (Reference KLD 2004 in Appendix E of the Environmental Report). Transient population data was included prior to population projection. This is consistent with the guidance in NEI 05-01. Transient data are most applicable to evacuation-related modeling.

4.c Section E.7.3.4 describes a population sensitivity case in which the 2040 population was uniformly increased by 30 percent in all sectors of the 5-mile radius. Section E.3.2 states that SECPOP2000 census data from 1990 to 2000 were used to determine the 10 year population growth factor. It is unclear if the 30 percent sensitivity case bounds the population growth rate if updated population growth estimates are used (see request for additional information (RAI) 4a). Provide an assessment of the impact on PDR and OECR using currently available population growth estimates for the surrounding counties and states.

PSEG Response:

As indicated in the response to RAI 4.a, the use of "whole county" growth estimates is not generally preferred since the resolution of such data is less than that available using the data contained in the SECPOP2000 census data.

Particularly, radial variations in growth rates may be significantly under represented using "whole county" data. Additionally, it is noted that the 10-year growth rates used in the SAMA analysis varied significantly, including growth rate factors as high as 1.38 (e.g., 4-5 mile ring).

It is also noted that the 30% population sensitivity performed for the 50-mile SAMA analysis was performed by increasing the 2046 population of each polar grid cell by 30% rather than by increasing the population growth factor by 30%. This is approximately equivalent to adding 5.9% to the 10-year growth percentage of each ring. For example, for the 30% sensitivity case, the equivalent 10-year growth for the 40-50 mile ring would be increased from 4% to 9.9%. Thus, the 30% sensitivity case is approximately equivalent to assuming the following 10-year growth percentages:

Radial Ring (miles)	Base Case 10-year Growth (%)	30% Sensitivity 10-year Equivalent Growth (%)
0-1	0	5.9
1-2	0	5.9
2-3	0	5.9
3-4	19	24.9
4-5	38	43.9
5-10	17	22.9
10-20	16	21.9
20-30	9	14.9
30-40	1	6.9
40-50	4	9.9

The table above is judged to represent a significant population growth adjustment that adequately bounds anticipated sustained growth through 2046. For the purposes of SAMA, the data utilized in the Hope Creek MACCS2 analysis, in combination with the 30% population sensitivity case, is judged to adequately support growth projections.

4.d Section 3.1.2 identifies the allowable fuel burnup and enrichment for HCGS. Clarify if this is consistent with the core inventory used in the SAMA analysis.

PSEG Response:

The nominal fuel enrichment and allowable fuel burn-up values provided in Section 3.1.2 represent limits used in environmental impact evaluations as described in 10 CFR 51.51 and 10 CFR 51.52. The bounding fuel enrichment and fuel burn-up values used to calculate the core inventory are less than these limits. The most recent calculation of core inventory was performed as part of the HCGS Extended Power Uprate (Amendment 174, ML081230640). This core inventory is used in the current Alternate Source Term (AST) analyses. Hope Creek was issued a License Amendment in October 2001 supporting full-scope implementation of AST as described in Regulatory Guide 1.183 (Amendment

134, ML012600176). The SAMA MACCS2 analysis was based on the core inventory used in the current AST analyses and thus is consistent with the current design and licensing bases.

5. Provide the following with regard to the SAMA identification and screening process:

5.a For most Table E.5-1 initiating events (e.g., %IE-SWS, %IE-TE, %IE-MS, %IE-TT, %IE-S2-WA) it is stated that "this initiator event is a compilation of industry and plant specific data (No specific SAMA identified.)." Provide assurance that for each of these initiating events there is not a dominant contributor for which a potential SAMA to reduce the initiating event frequency or mitigate the impact of the initiator would not be viable. For example, while the above statement is made for initiator %IE-SWS, potential SAMAs were in fact identified for event NR-IE-SWS, Non-recovery of the loss of SWS initiator.

PSEG Response:

Typically, the importance list review process includes not only the consideration of the event itself, but the series of events that lead up to, and follow, the event of importance. SAMAs are derived not only to bypass or improve the reliability of the components or actions represented by the event, but to also find ways to reduce challenges to the action/component or to mitigate the failure of the action/component.

For any given initiating event on the importance list, the events important to the initiator are generally also represented on the importance list. Given that this is true, the approach taken in the HCGS importance list review was to treat the initiators separately to clarify the nature of how the initiating event values were derived.

For documentation purposes, the contributors to each of the important initiating events have been identified and correlated to the importance list review that was provided in the ER:

- %IE-SWS (LOSS OF SERVICE WATER INITIATING EVENT): 100 percent of the cutsets including this initiating event include the event NR-IE-SWS, which is addressed in the importance list review (refer to the response to RAI 5b for additional information about the disposition of this initiating event). Therefore, the important sequences including %IE-SWS have been considered.
- %IE-TE (LOSS OF OFFSITE POWER INITIATING EVENT): Loss of offsite power events are well represented in the importance list review. For example, the following events, which are important to the scenarios which involve the %IE-TE initiator, are all addressed by the importance list review: LOOP-IE-SW, NR-XTIE-EDG, OSPR20HR-SW, DCP-XHE-PORTA, RX-FWR-POR, DGS-DGN-FS-BG400, DGS-DGN-FS-DG400, HPI-TDP-FS-OP204, and OSPR7HR-SW. The SAMAs that were identified to mitigate these scenarios include:
    - o SAMA 1: Remove ADS inhibit from non-ATWS emergency operating procedures (reduces high pressure core melts in LOOP scenarios)
    - o SAMA 5: Restore AC power with onsite gas turbine (provides an alternate AC power source for LOOP events)

  - SAMA 10: Provide procedural guidance to use B.5.b low pressure pump for non-security events (mitigates long term SBO scenarios)

- %IE-MS (MANUAL SHUTDOWN INITIATING EVENT): Manual shutdown scenarios are well represented in the importance list review. For example, the following events, which are important to the scenarios which involve the %IE-MS initiator, are all addressed by the importance list review: RHS-REPAIR-TR, ADS-XHE-OK-INHIB, NR-U1X-DEP-SRV, ACP-BAC-HV-RMCLG, VIS-FAN-FS-DF01, and VIS-FAN-FS-DF12. The SAMAs that were identified to mitigate these scenarios include:

  - SAMA 1: Remove ADS inhibit from non-ATWS emergency operating procedures (reduces high pressure core melts in LOOP scenarios)
  - SAMA 4: Provide procedural guidance to cross-tie RHR trains (mitigates power and equipment failures in the heat removal and low pressure injection trains)
  - SAMA 16: Use of different designs for switchgear room cooling fans (mitigates loss of SWGR room cooling events)
  - SAMA 17: Replace a supply fan with a different design in Service Water pump room
  - SAMA 18: Replace a return fan with a different design in Service Water pump room

- %IE-TT (TURBINE TRIP WITH BYPASS): There are a diverse set of contributors for this initiating event. About 60 percent of the risk can be attributed to the failure to depressurize after high pressure injection failure, pneumatic supply failures for certain valves, and to a lesser extent, failures of Service Water room cooling fans. These failures are addressed by SAMAs 1, 17, and 18. Further review of the relevant basic events indicates that the "pneumatic supply failure" description may be misleading. Because the pneumatic supply path is modeled separately, the actual basic event more likely represents a failure of the valve to stroke. The PRA model conservatively does not credit local action as a means of operating the vent valve when this type of failure occurs. However, whether the valve failures are due to a pneumatic supply failure or a general failure to stroke, the local venting action, which is proceduralized and credited for other failures, should be credited to mitigate these failures. When local venting is credited to mitigate the relevant remote valve operation failures, these scenarios are no longer important contributors.

- %IE-S2-WA (SMALL LOCA - WATER (BELOW TAF): The Small LOCA contribution is dominated by a single cutset (about 70% of the small LOCA frequency) that involves successful ADS inhibit followed by failure to depressurize without high pressure injection. As a result, SAMA 1 was identified as the primary means of addressing small LOCAs.

- %IE-S2-ST (SMALL LOCA - STEAM (ABOVE TAF)): The situation for this initiating event is the same as for %IE-S2-WA, but even more heavily weighted toward successful ADS inhibit and subsequent failure to depressurize.

- %IE-TC (LOSS OF CONDENSER VACUUM): There are a diverse set of contributors for this initiating event. About 50 percent of the risk can be attributed to the failure to depressurize after high pressure injection failure, pneumatic supply failures for certain valves, and divisional failures of RHR. These failures are addressed by SAMAs 1 and 4. The pneumatic supply failures are not valid contributors, as described for %IE-TT above.

- %FL-FPS-5302 (INTERNAL FLOOD OUTSIDE LOWER RELAY ROOM): This event is completely tied to the event "LCER-PHE-DOOR", which is addressed in the importance list review (SAMA 8 is the mitigating plant enhancement).

- %IE-TM (MSIV CLOSURE): There are a diverse set of contributors for this initiating event; however, over 50 percent of the risk can be attributed to the failure to depressurize after high pressure injection failure. This is addressed by SAMA 1.

- %FLSWAB-RACS-U (FREQ OF COMMON HEADER TO RACS RUPTURE (UNISOLABLE)): This event is completely tied to the event "SWS-XHE-RACS-UNI", which is addressed in the importance list review (SAMA 7 is the mitigating plant enhancement).

- %IE-SACS (LOSS OF SACS INITIATING EVENT): There are a diverse set of contributors for this initiating event; however, about 50 percent of the risk can be attributed to the failure to depressurize after high pressure injection failure. This is addressed by SAMA 1. An additional 8 percent of the contributors include event IAS-MDC-FR-K100 (failures of the EIA compressor), which is also addressed on the importance list (linked to SAMA 3).

- %IE-TF (LOSS OF FEEDWATER): There are a diverse set of contributors for this initiating event; however, over 50 percent of the risk can be attributed to the failure to depressurize after high pressure injection failure. This is addressed by SAMA 1.

- %FLSWA-RACS-U (FREQ. OF UNISOLABLE SW A PIPE RUPT IN RACS ROOM): This event is completely tied to the event "SWS-XHE-RACS-UNI", which is addressed in the importance list review (SAMA 7 is the mitigating plant enhancement).

- %FLSWB-RACS-U (FREQ. OF UNISOLABLE SW B PIPE RUPT. IN RACS ROOM): This event is completely tied to the event "SWS-XHE-RACS-UNI", which is addressed in the importance list review (SAMA 7 is the mitigating plant enhancement).

- %FLTORUS (TORUS RUPTURE IN TORUS ROOM): The importance of this initiating event is driven by failure of the feedwater heater bypass valves and the feedwater pump bypass valve. Failure of these valves to open is conservatively modeled as failing the Condensate/Feedwater pathway; however, the normal path through the feedwater heaters and the feedwater pumps would be available as an injection path. If the bypass valve failures are treated as an alternate feed path rather than the only feed path, these contributors would no longer be meaningful contributors for the %FLTORUS initiating event. When these valves are treated as an alternate feed path, the residual contribution to CDF from the events related to %FLTORUS is only 6.95E-09/yr. Of this residual contribution, a portion is related to the failure to depressurize after high pressure injection failure as well as failures of the plant air compressors. These failures are addressed by SAMAs 1 and 3, respectively. The component of risk that is not addressed by any SAMA corresponds to a CDF (and LERF) value of 4.66E-09/yr. If all of these contributors were eliminated by a SAMA, the averted cost risk would be about $72,000 (assuming all LERF is binned to ST3). These "untreated" scenarios are dominated (65%) by a joint human error probability related to the failure to use Condensate for injection and to initiate RHR for heat removal (JHEP=1.2E-03). The use of the Condensate and RHR systems is well understood and practiced; training is provided in the simulator, the systems are used as part of normal operations, and the procedures are continuously reviewed and updated by the plant training group. Any potential changes that could impact the reliability of these actions are considered to have been addressed by this normal plant process. In summary, the small contributions from the %FLTORUS initiating event are considered to be either addressed by existing SAMAs (1 and 3) or addressed by an existing plant process (procedure review and update by training group). No additional SAMAs are suggested.

5.b For Table E.5-1 event NR-IE-SWS, Non-recovery of the loss of SWS initiator, two potential SAMAs were identified. Since the loss of service water system (SWS) initiating event frequency is input as a basic event rather than derived from a model of the HCGS SWS system, it is not clear that the SAMAs identified (a back up air compressor or cross-tieing the residual heat removal (RHR) pumps) would lead to recovery. Discuss these identified SAMAs and the potential for other mitigation strategies.

PSEG Response:

The event "RHS-REPAIR-TR" (REPAIR/RECOVERY OF RHR FOR LOSS OF DHR EVENTS (TRANSIENT EVENTS)) is a significant contributor to loss of service water scenarios. The general nature of the restoration failure is considered to include not only RHR components themselves, but also some support systems. In this case, the Service Water recovery event is set to 1.0, so repair credit for the overall DHR function would not be double-counted. With respect to how SAMA 4 relates to the restoration failure, the restoration failure may include scenarios in which the "A" and "B" RHR pump trains cannot be restored when the "C" and "D" trains are restored. In these cases, RHR pumping capacity would be available, but heat removal capability would not be available.

The ability to use the existing RHR inter-train cross-tie (i.e., the "C" ("D") RHR pump can be aligned for alternate decay heat removal (ADHR) utilizing the "A" ("B") RHR HX) would address these scenarios. The ADHR alignment is not credited in the HC108B PRA model.

SAMA 3 was developed to address failures that the PRA identifies as "pneumatic supply failures" for the containment vent valves. These failures are prominent in the loss of Service Water scenarios because failure of the containment vent path eliminates the alternate means of containment heat removal. Further review of the relevant basic events indicates that the "pneumatic supply failure" description may be misleading. Because the pneumatic supply path is modeled separately, the actual basic event more likely represents a failure of the valve to stroke. The PRA model conservatively does not credit local action as a means of operating the vent valve when this type of failure occurs. However, whether the valve failures are due to a pneumatic supply failure or a general failure to stroke, the local venting action, which is proceduralized and credited for other failures, should be credited to mitigate these failures. When local venting is credited to mitigate the relevant remote valve operation failures, these scenarios are no longer important contributors.

An additional SAMA that is applicable to the loss of Service Water scenarios is SAMA 15, "Alternate design of CSS suction strainer to mitigate plugging". Strainer plugging is important for loss of Service Water scenarios given that Core Spray could be used to prevent core damage when containment venting is used for heat removal.

As with most transient scenarios, SAMA 1 is also applicable to the high pressure injection failure scenarios.

In summary, SAMAs 4, 15, 1, and credit for the existing local venting action address over 82% of the risk associates with NR-IE-SWS. No additional SAMAs are required.

5.c For Table E.5-1 event SAC-XHE-MC-DF01, Dependent failure of miscalibration of temperature controller HV-2457S, it is indicated that because of the low probability of this event and the existing procedural guidance for calibration there is limited opportunity for improvement. Assess whether a redundant controller using diverse components and calibration techniques would reduce the importance of this event.

PSEG Response:

It may be possible to reduce the risk associated with miscalibrations of temperature controller HV-2457S by installing a redundant controller, but there are at least two factors that preclude the need for any changes:

- Plant instrumentation, alarms, and procedures already exist that would identify failure of the temperature controllers and provide guidance to locally close the

Safety Auxiliaries Cooling System (SACS) Heat Exchanger bypass valves (HV-2457A/B), as required.

- The SACS is normally in operation and any gross temperature controller miscalibrations would be revealed through normal system operation.

On high system temperature (above 88 degrees F), an alarm is tripped which is linked to an overhead alarm procedure that directs the operators to confirm proper operation of HV-2457A/B.

The SACS abnormal operating procedure, which is also linked to the SACS high temperature alarm, directs the operators to ensure the HV-2457A/B are closed. Operator training supports local operation of valves when they do not operate remotely. Valves HV-2457A/B are equipped with manual operators that can be used to close the valves.

Without considering the fact that temperature controller miscalibrations would be discovered during normal plant operations, crediting the local action to manually close the HV-2457A/B valves with a 0.1 failure probability would reduce the risk reduction worth value for SAC-XHE-MC-DF01 to 1.005, which is at the bottom of the review threshold even when the LLNL seismic hazard curves are considered (refer to the response to RAI 5.j).

Given that procedures are available to direct local operation of the HV-2457A/B on temperature controller failure and that the failures are related to long term loss of decay heat removal scenarios, installation of a diverse temperature controller would not be warranted.

5.d For Table E.5-1 events CAC-AOV-CC-11541, Pneumatic supply to HV-11541 fails; CAC-AOV-CC-4964, Pneumatic supply to HV-4964 fails; CAC-XHE-FO-LVENT, Local venting through 12" line fails; NR-VENT-5-03, Failure to initiate containment vent given SPC hardware failure; and NR-RHRVENT-INIT, Failure to initiate vent given failure to initiate RHR in SPC, assess whether a modification to change the venting system to a passive design (e.g., through use of a rupture disk) would be a feasible alternative.

PSEG Response:

As described in the response to RAI 5.a, the PRA model conservatively does not credit the proceduralized local containment venting action to mitigate the "pneumatic supply failure" event (e.g., CAC-AOV-CC-11541). If credit is taken for the local containment venting action, these events are no longer important contributors.

With regard to mitigating scenarios in which the operators fail to initiate containment venting, a passive venting design would provide a physical mechanism for containment venting, but it would limit the functionality of the hard pipe vent and reduce the control operators have over the containment.

Specifically, the use of a rupture disk in the hard pipe vent path restricts the usefulness of the vent pathway. The hard pipe vent exhibits a significant benefit in the following sequences:

- Combustible gas venting
- SAMG directed venting to enhance RPV or containment injection

By placing a rupture disk in the line, the hard pipe vent cannot be used until containment pressure exceeds the vent pressure.

It is judged that the loss in flexibility of the hard pipe vent imposes competing risks that have not been evaluated but are believed to be comparable to any benefit associated with the implementation of the rupture disk.

In addition, the premature opening of the rupture disk (e.g., given a LOCA or an ATWS with clad perforations) could result in the release of fission products (i.e., noble gases) from containment, thereby compromising the containment function.

For these reasons, a modification to change the venting system to a passive vent design is not considered to be a feasible alternative.

5.e For Table E.5-1 event %FL-FPS-5302, Internal flood outside lower relay room, assess whether flood barriers are a potential SAMA to mitigate this event.

PSEG Response:

Table E.5-1 incorrectly states that no specific SAMA was identified for this event. This event is addressed by SAMA 8, which was determined to be cost beneficial. The %FL-FPS-5302 event is the initiator for the FPS pipe rupture in the corridor outside the Lower Relay Room (also called the Lower Control Equipment Room, or Room 5302). SAMA 8 proposes the conversion of this wet pipe system to a dry pipe system. The conversion to a dry pipe system was judged preferable to developing flood barriers for the multiple doors that exist in this corridor.

5.f For a significant number of Table E.5-1 events, such as DCP-BDC-ST-DF01, CSS-MDP-TM-PAC, and %IE-SACS, no SAMAs were identified based on low contribution to Level 1 and Level 2, and engineering judgment that the anticipated implementation costs of hardware modifications associated with mitigating the event would likely exceed the expected cost-risk benefit. This criterion for identifying potential SAMAs is not in accordance with the stated criteria for selection and screening and does not account for the potential for procedural changes or the impact of uncertainty. Provide assurance for each of the events for which no SAMAs were identified on the above, or similar, basis that no SAMAs are feasible that merit further consideration. This assessment should also account for the impact of uncertainty.

PSEG Response:

As identified in this RAI, multiple events in Table E.5-1 of the ER indicate that a SAMA was not identified based on the event's low risk reduction worth value and the high cost of potentially applicable hardware modifications. Table 5.f-1 provides a revised assessment of each of these events.

Table 5.f-1

UPDATED DISPOSITION OF LOW IMPORTANCE EVENTS ASSOCIATED WITH POTENTIALLY HIGH COST SAMAS (LEVEL 1)

Event Name	Probability	Level 1 Risk Reduction Worth	Description	Comments or Potential SAMAs
DCP-BDC-ST-DF01	3.87E-08	1.021	CCF FAILURE 125VDC BUSES 10D410 - 20 - 30 - & 40	HCGS has procedures to operate RCIC without AC or DC power that are not credited. While failure of the DC panels in the earliest time frames of an accident may preclude full implementation of the procedure, it is expected that many of the scenarios could be mitigated with local RCIC operation. No additional SAMAs required.
CSS-MDP-TM-PAC	1.36E-02	1.018	CSS PUMP TRAINS A AND C IN TEST AND MAINT	Over 80% of the contributors including this event also include CSS suction strainer clogging events. SAMA 15 would mitigate these scenarios. No additional SAMAs required.
CSS-MDP-TM-PBD	1.36E-02	1.018	CSS PUMP TRAINS B AND D IN TEST AND MAINT	Over 80% of the contributors including this event also include CSS suction strainer clogging events. SAMA 15 would mitigate these scenarios. No additional SAMAs required.
%IE-SACS	1.16E-04	1.017	LOSS OF SACS INITIATING EVENT	Refer to the response to RAI 5.a for additional information pertaining to the disposition of this event. No additional SAMAs required.
%FLSWAB-RACS-U	7.60E-08	1.017	FREQ OF COMMON HEADER TO RACS RUPTURE (UNISOLABLE)	These flooding scenarios can be addressed by SAMA 7. No additional SAMAs required.
SAC-AOV-OO-DF01	2.26E-05	1.015	CCF FAILURE OF HV-2457A AND B VALVES	HCGS has procedure that would direct local operation of these valves, but the PRA conservatively does not credit the action. If credit is taken, they are no longer significant contributors. No additional SAMAs required.

Table 5.f-1

UPDATED DISPOSITION OF LOW IMPORTANCE EVENTS ASSOCIATED WITH POTENTIALLY HIGH COST SAMAS (LEVEL 1)

Event Name	Probability	Level 1 Risk Reduction Worth	Description	Comments or Potential SAMAs
RHS-STR-PL-PB	4.21E-03	1.014	RHR SUCTION STRAINER B PLUGGED IN STANDBY	About 60% of the scenarios including this event are related to fire protection system floods. SAMA 8 addresses these contributors. An additional 15% of the contributors include the failure to manually depressurize the reactor, which are addressed by SAMA 1. No additional SAMAs required.
RPT-PIP-RP-SEALS	9.50E-01	1.014	COND. PROB. OF SMALL RECIRC SEAL LOCA GIVEN SBO	Over 30% of the contributors including this event are related to failure of the SACS Hx Bypass valves or the temperature controller for the valves (leads to SBO in a LOOP). If credit is taken for existing procedures and training, these contributors would effectively be eliminated. The remaining contributors are addressed by SAMA 5. No additional SAMAs required.
%FLSWA-RACS-U	5.70E-08	1.013	FREQ. OF UNISOLABLE SW A PIPE RUPT IN RACS ROOM	These flooding scenarios can be addressed by SAMA 7. No additional SAMAs required.
%FLSWB-RACS-U	5.70E-08	1.013	FREQ. OF UNISOLABLE SW B PIPE RUPT. IN RACS ROOM	These flooding scenarios can be addressed by SAMA 7. No additional SAMAs required.
HPI-TDP-FS-DFP01	3.17E-04	1.013	CCF FAILURE OF HPCI AND RCIC TDP TO START	Almost 90% of the contributors including this event also include manual depressurization failure. SAMA 1 addresses these scenarios. No additional SAMAs required.

Table 5.f-1

UPDATED DISPOSITION OF LOW IMPORTANCE EVENTS ASSOCIATED WITH POTENTIALLY HIGH COST SAMAS (LEVEL 1)

Event Name	Probability	Level 1 Risk Reduction Worth	Description	Comments or Potential SAMAs
SRV-TNK-LK-TRANS	1.00E-04	1.011	FAILURE OF 13/14 ACCUMULATORS (LEAKAGE) (NON-SBO)	Almost all of the contributing scenarios include HPCI/RCIC success. Credit is conservatively not taken for the gradual cooldown that would occur and the ability to transition to RHR for level control and heat removal. If this controlled transition was credited, these contributors would be eliminated. No additional SAMAs required.
CSS-MDP-TM-PA	7.51E-03	1.010	CSS PUMP TRAIN A IN TEST AND MAINT	Almost 85% of the contributors including this event also include CSS suction strainer clogging events. SAMA 15 addresses these scenarios. No additional SAMAs required.
CSS-MDP-TM-PC	7.51E-03	1.010	CSS PUMP TRAIN C IN TEST AND MAINT	Almost 85% of the contributors including this event also include CSS suction strainer clogging events. SAMA 15 addresses these scenarios. No additional SAMAs required.
LPI-XHE-AT-LVL	4.00E-02	1.006	FAILURE TO CONTROL LP ECCS TO PREVENT OVERFILL	About 60% of the contributors including this event include failure to bypass the low level MSIV isolation logic. This is addressed the response to RAI 5.j by SAMA RAI5j-IE1. No additional SAMAs required.
NR-U1X-DEP-10M	3.20E-02	1.006	FAILURE TO MANUALLY DEPRESSURIZE THE RPV WITHIN 10 MIN.	Manual depressurization failures are addressed by SAMA 1. No additional SAMAs required.
SWS-MOV-VF-SPRAY	1.00E-01	1.006	Flood - SPRAY CAUSES MOV FAILURE IN RACS COMPARTMENT	Refer to the response to RAI 5.g.

5.g For Table E.5-1 event SWS-MOV-VF-SPRA, Flood–spray causes MOV failure in RACs compartment, it is stated that there is no feasible SAMA to mitigate the potential for MOV failure due to spray damage. Discuss the feasibility of installing a spray shield to address this failure.

PSEG Response:

Based on a review of the design requirements of the isolation valves, it was determined that they are NEMA Type 4 enclosures and are qualified to withstand spray events (NEMA 2008). The current PRA model conservatively assumes a 0.1 failure probability for a spray event, but no equipment enhancements are required to ensure that these valves are available in the relevant flooding events. In addition, the PRA conservatively assumes that all of the postulated flooding events would result in spray impingement on the isolation valves. Even if it is assumed that 1 in 10 events result in a direct spray impact, these events would no longer remain above the importance review threshold. As a result, no additional SAMAs are required.

REFERENCES

NEMA 2008 NEMA Standards Publication 250-2008, "Enclosures for Electrical Equipment (1000 Volts Maximum)", National Electrical Manufacturers Association, Rosslyn, VA, 2008.

5.h For Table E.5-2 event CNT-DWV-FF-MLTFL, Drywell (DW) shell melt-through failure due to containment failure, assess whether a barrier or curb to protect the DW shell would be a feasible alternative to reduce the probability of early failure due to DW shell melt-through.

PSEG Response:

The event "CNT-DWV-FF-MLTFL" is a flag event used in the HCGS model for Class II, IIID, and IV scenarios given that these accident sequences define conditions for which drywell shell melt-through is assumed to occur because the PRA model does not credit any water injection during the Level 2 accident progression. For these sequences, the addition of a barrier or curb in the drywell would not have a meaningful impact on the results given the following:

- Injection is not available: Without injection to the RPV/containment, the barrier alone would not prevent drywell shell melt-through given that water is required to provide debris cooling. Without cooling, the core debris would degrade the barrier to the point of failure.
- Pre-existing containment failures already provide an early release pathway (e.g., long term containment overpressure failure in Class II scenarios). For

cases in which a drywell break or a suppression pool water space break has occurred during the Level 1 accident progression, preventing drywell shell melt-through would have little or no impact on the magnitude of a release given that an unscrubbed release pathway would already exist. For breaks in the wetwell airspace, scrubbing of the release would otherwise be available and preventing the drywell shell melt-through would theoretically provide some benefit. As noted above, however, injection is failed for the scenarios related to "CNT-DWV-FF-MLTFL".

It should be noted that the HCGS model includes an event representing the failure of a barrier such as the one described in this RAI question; however, it is set to 1.0 given that the barrier does not exist at HCGS. The barrier failure event is included in sequences for which water would potentially be available to cool the core debris, but the risk reduction worth is a 1.0 (making the barrier 100% effective does not change the "high" or "moderate" release category results).

5.i For Table E.5-2 events CIS-DRAN-L2-OPEN, Valves open automatically for drainage normally open, and CIS-XHE-FO-DRN-E, Operator fails to locally close equipment drain and floor drain MOV in RB-early, replacing the MOVs with fail closed AOVs is identified as a more costly alternative to SAMA 5, Restoring AC power with onsite gas turbine generator. While the alternative may be more costly, it also might be more effective and have a larger cost-risk reduction. Provide a further evaluation of the costs and benefits for this alternative.

PSEG Response:

Changing a valve to a "fail closed" design is a potential means of increasing the probability that a valve is closed in a loss of power scenario. However, while the scope of addressing event "CIS-DRAN-L2-OPEN" may appear to be limited, this event represents more than one valve. At least one MOV in each of two drain pathways would have to be replaced in order to ensure closure of the pathways in loss of power scenarios:

- HBV-045 OR HBV-046 (drywell equipment drain line),

  AND

- HBV-005 OR HBV-006 (drywell floor drain line).

The release frequency associated with event CIS-DRAN-L2-OPEN for the "high" and "moderate" release categories is 9.12E-8/yr. About 25 percent of the contributors are from sequences in which long term venting is not credited (e.g., LOOP without AC power recovery) to prevent containment failure and subsequent core damage. If credit is taken for the existing local venting procedures (event CAC-XHE-FO-LVEN, HEP equal to 6.2E-02), this portion of the contribution is essentially eliminated. In addition, failures of the SACS heat exchanger bypass valves (event SAC-AOV-OO-DF01) or the temperature controller (event SAC-XHE-MC-DF01) are addressed by existing procedures, but the model conservatively does not credit local action to mitigate the failures. If a failure probability of 0.1 is assumed for a local recovery action, the contributions are significantly decreased.

After crediting the existing plant procedures, the residual release frequency is estimated to be 5.62E-08/yr, which is primarily distributed among the ST1, ST2, and ST4 release categories. If all of these scenarios are assumed to be associated with the ST2 release category (representative of the contributors), the averted cost-risk of a SAMA that eliminates all of the releases would be $712,103 (using the external events multiplier of 6.8 from the response to RAI 5.j). Table 5.i-1 summarizes the changes that were made to the release category frequencies (note that while 5.62E-08 was subtracted from ST2, it was added to ST11 since this SAMA would not reduce the CDF).

With regard to the cost of implementation, TMI SAMA 31 (Exelon 2008) proposed a highly similar enhancement in which two MOVs in cooling water systems were to be exchanged with "fail closed" solenoid operated AOVs. The cost of TMI SAMA 31 was estimated to be $4,100,000. Given that the sizes of the HCGS drain line valves are smaller and that the functions of the drain line pathways are less complicated than those in the cooling water systems, it is assumed that the cost of implementation for HCGS is 1/2 of the TMI SAMA 31 cost, or about $2,050,000.

The net value of the change proposed in this RAI is the difference between the averted cost-risk and the cost of implementation:

$$\text{Net Value} = \$712{,}103 - \$2{,}050{,}000 = -\$1{,}337{,}897$$

The large, negative net value indicates that this SAMA is not cost beneficial. Even if the 95th percentile PRA results are used in conjunction with an external events multiplier of 6.8, the net value is still negative:

$$\text{Net Value}_{\text{95th percentile PRA Results}} = (\$712{,}103 * 2.84) - \$2{,}050{,}000 = -\$27{,}628$$

REFERENCES

Exelon 2008 — Exelon Generation Company, LLC (Exelon). 2008. *Applicant's Environmental Report; Operating License Renewal Stage; Three Mile Island Unit 1.* Appendix E - Severe Accident Mitigation Alternatives Analysis. January.

Table 5.i-1
RESULTS SUMMARY BY RELEASE CATEGORY (CHANGE TO "FAIL CLOSED" VALVES)

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	Total
$Frequency_{BASE}$	1.83E-07	7.15E-08	1.30E-07	9.70E-07	8.34E-08	3.48E-07	2.16E-07	0.00E+00	2.68E-07	2.39E-07	1.93E-06	**4.44E-06**
$Frequency_{SAMA}$	1.83E-07	1.53E-08	1.30E-07	9.70E-07	8.34E-08	3.48E-07	2.16E-07	0.00E+00	2.68E-07	2.39E-07	1.99E-06	**4.44E-06**
$Dose\text{-}Risk_{BASE}$	3.33	0.99	3.05	8.49	0.92	4.55	1.37	0.00	0.00	0.16	0.00	**22.86**
$Dose\text{-}Risk_{SAMA}$	3.33	0.21	3.05	8.49	0.92	4.55	1.37	0.00	0.00	0.16	0.00	**22.09**
$OECR_{BASE}$	$21,045	$6,888	$14,975	$62,159	$7,694	$31,881	$10,235	$0	$0	$177	$0	**$155,055**
$OECR_{SAMA}$	$21,045	$1,476	$14,975	$62,159	$7,694	$31,881	$10,235	$0	$0	$177	$0	**$149,643**

5.j The external events multiplier and review of potential seismic-related SAMAs were based on use of the Electric Power Research Institute (EPRI) seismic hazard curve for HCGS (in contrast to the Lawrence Livermore National Laboratory (LLNL) seismic hazard curve used for Salem Generating Station SAMA analysis). It appears that use of the LLNL seismic hazard curve or U.S. Geological Survey 2008 seismic hazard data would result in larger estimated benefits for SAMAs, and possibly additional, potentially cost-beneficial SAMAs for HCGS. Provide an assessment of the impact on the SAMA identification and screening process if the seismic CDF and external event multiplier were based on use of the LLNL seismic hazard curve rather than the EPRI curve.

PSEG Response:

Use of the LLNL seismic hazard curves in place of the EPRI curves will impact the external events multiplier, the maximum averted cost-risk (MACR) for the site, the depth of the internal events importance review, and potentially the number of fire and seismic contributors requiring review in the SAMA identification process. Each of these issues must be re-assessed in order to determine how the use of the LLNL seismic hazard curve impacts the HCGS SAMA identification process. The steps required to complete this task are as follows:

- Recalculate the seismic CDF.
- Recalculate the external events multiplier.
- Recalculate the MACR.
- Update the fire and seismic potential averted cost-risk (PACR) calculations.
- Identify the fire areas and seismic scenarios with PACR values greater than $100,000.
- Review any areas/scenarios that were not reviewed as part of the ER.
- Establish the new internal events importance list RRW review threshold based on the updated MACR.
- Review any new events that fall above the RRW review threshold and identify the SAMAs required to mitigate the risk associated with those events.

Recalculation of the Seismic CDF

The HCGS seismic CDF can be updated to reflect the LLNL seismic hazard curves using the conditional core damage probability (CCDP) information provided in Section E.5.1.7.2 of the HCGS Environmental Report (ER) and the LLNL seismic hazard curve data provided in Table 3-7 of the HCGS IPEEE (PSEG 1997). Table 5j-1 summarizes the updated CDF values for each seismic-induced equipment damage states.

Table 5j-1
UPDATED HCGS SEISMIC RESULTS BASED ON THE LLNL SEISMIC HAZARD CURVES

BASIC EVENT ID	DESCRIPTION	Seismic Hazard Frequency (/yr) (LLNL)	CCDP	Seismic CDF (/yr)	% of Seismic CDF
%IE-SET36	Seismic-Induced Equipment Damage State SET-36 (Impacts - 120V PNL481)	2.50E-06	1.00E+00	2.50E-06	69.8%
%IE-SET18	Seismic-Induced Equipment Damage State SET-18 (Impacts - LOOP)	6.30E-05	5.20E-03	3.28E-07	9.1%
%IE-SET37	Seismic-Induced Equipment Damage State SET-37 (Impacts - 125V)	4.40E-07	1.00E+00	4.40E-07	12.3%
%IE-SET35	Seismic-Induced Equipment Damage State SET-35 (Impacts - 120V PNL482, RSP)	1.60E-07	1.00E+00	1.60E-07	4.5%
%IE-SET38	Seismic-Induced Equipment Damage State SET-38 (Impacts - 1E Panel Room Ventil.)	5.40E-08	1.00E+00	5.40E-08	1.5%
%IE-SET26	Seismic-Induced Equipment Damage State SET-26 (Impacts - LOOP, 250V)	3.80E-06	9.04E-03	3.44E-08	1.0%
%IE-SET09	Seismic-Induced Equipment Damage State SET-09 (Impacts - 250V)	8.10E-07	1.04E-02	8.42E-09	0.2%
%IE-SET34	Seismic-Induced Equipment Damage State SET-34 (Impacts - CR, RSP)	4.60E-08	1.00E+00	4.60E-08	1.3%
%IE-SET28	Seismic-Induced Equipment Damage State SET-28 (Impacts - LOOP, 250V, CV)	6.70E-07	6.00E-03	4.02E-09	0.1%
%IE-SET30	Seismic-Induced Equipment Damage State SET-30 (Impacts - LOOP, 250V, CST)	8.10E-07	6.00E-03	4.86E-09	0.1%
%IE-SET27	Seismic-Induced Equipment Damage State SET-27 (Impacts - S2, LOOP, 250V)	2.40E-07	1.00E-02	2.40E-09	0.1%
%IE-SET13	Seismic-Induced Equipment Damage State SET-13 (Impacts - 250V, CST)	6.10E-08	1.00E-02	6.10E-10	0.0%
%IE-SET03	Seismic-Induced Equipment Damage State SET-03 (Impacts - CV)	6.00E-07	5.00E-04	3.00E-10	0.0%
%IE-SET11	Seismic-Induced Equipment Damage State SET-11 (Impacts - 250V, CV)	5.80E-08	1.00E-02	5.80E-10	0.0%
%IE-SET20	Seismic-Induced Equipment Damage State SET-20 (Impacts - LOOP, CV)	1.60E-06	2.50E-04	4.00E-10	0.0%
			Total =	3.58E-06	

Recalculation of the Seismic CDF

The HCGS external events multiplier can be recalculated using the updated seismic CDF of 3.58E-06 using the same process outlined in section E.4.6.2 of the ER.

The contributions of the external events initiators are summarized in the following table:

IPEEE CONTRIBUTOR SUMMARY EXTERNAL EVENT INITIATOR GROUP CDF

Fire	1.74E-05
Seismic (LLNL)	3.58E-06
High Winds	1.00E-06
Transportation & Nearby Facility*	1.00E-06
External Flooding	1.00E-06
Detritus**	1.00E-06
Chemical Release	1.00E-06
Total EE CDF	2.59E-05

* The CDF for accidental aircraft impact was estimated to be 6.7E-8/yr in the HCGS UFSAR, Revision 7, December 29, 1995.

** Detritus CDF from IPEEE ranged from 5.2E-7 to 9.2E-7.

The external events multiplier is the ratio of total CDF (including internal and external) to only internal events CDF, which is calculated as follows:

EE Multiplier = (4.44E-06+2.59E-05) / (4.44E-06) = 6.8

Recalculation of the MACR

The MACR is the product of the maximum internal events averted cost-risk documented in Section E.4.6.1 of the ER and the external events multiplier calculated above:

MACR = $3,144,000 * 6.8 = $21,379,200

Update Fire and Seismic PACRs

The PACR values for each of the fire areas has been estimated by multiplying the MACR by the ratio of the CDF for the fire area to the total site CDF (4.44E-06 + 2.59E-05 = 3.03E-05/yr). As documented in Table 5j-2, no new fire areas require evaluation based on the use of the LLNL seismic hazard curves. All areas with PACRs greater than $100,000 were reviewed as part of the ER submittal.

Table 5j-2
UPDATED FIRE CONTRIBUTOR SUMMARY

BASIC EVENT ID	DESCRIPTION	Freq. (/yr)	CCDP	IE CDF (/yr)	% of Fire CDF	Compartment Fire MACR
%IE-FIRE03	Control Room Fire Scenario Small Cab_3 (Loss of Emer. Bat.)	2.94E-04	1.80E-02	5.292E-06	30.5%	$3,733,951
%IE-FIRE02	Control Room Fire Scenario Small Cab_2 (Loss of SSWS)	2.45E-04	1.80E-02	4.410E-06	25.4%	$3,111,626
%IE-FIRE01	Control Room Fire Scenario Small Cab_1 (Loss of SACS)	2.10E-04	1.80E-02	3.780E-06	21.8%	$2,667,108
%IE-FIRE28	Cmprtmnt 5339 Fire Scenario 5339_2	1.25E-05	6.00E-02	7.500E-07	4.3%	$529,188
%IE-FIRE37	DG Room (D) Fire Scenario 5304_2	1.00E-04	6.98E-03	6.980E-07	4.0%	$492,498
%IE-FIRE20	DG Room (C) Fire Scenario 5306_2	1.00E-04	6.67E-03	6.670E-07	3.8%	$470,625
%IE-FIRE38	Cmprtmnt 3425/5401 Fire Scenario 5401_1	3.40E-05	1.72E-02	5.848E-07	3.4%	$412,626
%IE-FIRE06	Control Room Fire Scenario Large Cab_1 (MSIV Closure)	2.55E-05	6.00E-02	5.100E-07	2.9%	$359,848
%IE-FIRE21	DG Room (B) Fire Scenario 5305_1	4.00E-03	2.09E-05	8.360E-08	0.5%	$58,987
%IE-FIRE24	Cmprtmnt 5501 Fire Scenario 5501_1	4.20E-04	1.90E-04	7.980E-08	0.5%	$56,306

For the seismic events, use of the LLNL seismic hazard curves resulted in the identification of two additional scenarios with PACRs greater than $100,000. The PACR for the next largest contributor is less than $60,000, as documented in Table 5j-3:

Table 5j-3
UPDATED SEISMIC CONTRIBUTOR SUMMARY

BASIC EVENT ID	DESCRIPTION	Seismic Hazard Frequency (/yr) (LLNL)	CCDP	Seismic CDF (/yr)	% of Seismic CDF	Compartment Seismic PACR
%IE-SET36	Seismic-Induced Equipment Damage State SET-36 (Impacts - 120V PNL481)	2.50E-06	1.00E+00	2.50E-06	69.8%	$1,763,960
%IE-SET37	Seismic-Induced Equipment Damage State SET-37 (Impacts - 125V)	4.40E-07	1.00E+00	4.40E-07	12.3%	$310,457
%IE-SET18	Seismic-Induced Equipment Damage State SET-18 (Impacts - LOOP)	6.30E-05	5.20E-03	3.28E-07	9.1%	$231,149
%IE-SET35	Seismic-Induced Equipment Damage State SET-35 (Impacts - 120V PNL482, RSP)	1.60E-07	1.00E+00	1.60E-07	4.5%	$112,893
%IE-SET38	Seismic-Induced Equipment Damage State SET-38 (Impacts - 1E Panel Room Ventil.)	5.40E-08	1.00E+00	5.40E-08	1.5%	$38,102
%IE-SET34	Seismic-Induced Equipment Damage State SET-34 (Impacts - CR, RSP)	4.60E-08	1.00E+00	4.60E-08	1.3%	$32,457
%IE-SET26	Seismic-Induced Equipment Damage State SET-26 (Impacts - LOOP, 250V)	3.80E-06	9.04E-03	3.44E-08	1.0%	$24,238
%IE-SET09	Seismic-Induced Equipment Damage State SET-09 (Impacts - 250V)	8.10E-07	1.04E-02	8.42E-09	0.2%	$5,944
%IE-SET30	Seismic-Induced Equipment Damage State SET-30 (Impacts - LOOP, 250V, CST)	8.10E-07	6.00E-03	4.86E-09	0.1%	$3,429
%IE-SET28	Seismic-Induced Equipment Damage State SET-28 (Impacts - LOOP, 250V, CV)	6.70E-07	6.00E-03	4.02E-09	0.1%	$2,836

Review/Evaluation of New Seismic Scenarios

%IE-SET37 - Seismic-Induced Equipment Damage State SET-37 (Impacts - 125V): This scenario represents seismic-induced failure of 1E power to all four 125V DC distribution panels (1A/B/C/D-D-417). The IPEEE assumes a conditional core damage probability of 1.0 for these scenarios.

The seismic model does not credit local operation of the systems impacted by this failure (e.g., Feedwater, RHR, CS, HPCI, RCIC, ADS). HCGS does have a procedure to operate RCIC without AC or DC power; however, long term room cooling issues (for local operator actions) and the limited time that is available to establish local RCIC control preclude crediting the existing procedure for seismic events.

A potential means of addressing the %IE-SET37 risk would be to reinforce the 125V DC panel anchorages, but even if 125V DC panel failures could be eliminated, other equipment failures would limit the benefit of this enhancement. For example, the HCLPF value listed for these panels in Table 3-5 of the HCGS IPEEE is 0.57g, which is substantially greater than the 0.33g value of the 120V AC panels that are addressed as part of SAMA 37. The implication is that even if the 125V DC panels were enhanced, the operators would be required to operate the plant without 120V AC power. The IPEEE does not credit operation of the plant without 120V AC power; however, for this evaluation, it is assumed that the operators would be successful 50 percent of the time. It follows that the plant could be controlled for half of the cases in which failure of the 125V DC panels is prevented through anchorage enhancement. Based on this assumption, the PACR for %IE-SET37 would be 50 percent of its original value assuming that the 125V DC panel enhancements always preclude seismically induced failure ($310,457 * 0.5 = $155,229). Using the 95th percentile PRA results, this PACR could be increased by a factor of 2.84 to $440,850.

Given the relatively high HCLPF value for the 125V DC panels, designing and implementing a means of reinforcing them so that they are significantly more robust would likely cost more than the changes proposed for the 1A/B/C/DJ481 panels in SAMA 37; however, the $500,000 implementation cost is assumed to be applicable for this evaluation. Even when this potentially low cost of implementation is used with the 95th percentile PRA results, reinforcing the 1A/B/C/D-D-417 125V DC panels would not be cost effective, as shown below:

Net Value = $440,850 - $500,000 = -$59,150

%IE-SET35 - Seismic-Induced Equipment Damage State SET-35 (Impacts - 120V PNL482, RSP): This scenario represents a seismic-induced failure of all four divisions of 1E 120V AC instrumentation distribution panels (1A/B/C/DJ482 panels) and subsequent failure to control the plant manually (without automated actuation from the associated logic circuits).

If all four of the 120V AC J482 panels fail, operator action can still prevent core damage. The 1A/B/C/DJ482 panels distribute 120V 1E AC power to various 1E logic cabinets. The failure of these logic cabinets causes a substantial loss of automatic actuation of 1E equipment, including diesel generator load sequencing and automatic Primary Containment Isolation System signals. However, manual operation of this equipment and manual diesel generator loading is still possible (e.g., at the Remote Shutdown Panel), and procedural guidance is available.

Enhancements could be made to align alternate power sources directly to logic loads using portable generators; however, human dependence issues would limit the credit of any SAMA requiring operator action. In these scenarios, the operators have procedures to manually operate equipment in the main control room to address the loss of 120V AC power; if they fail to perform these relatively simple actions, it would be difficult to justify credit for additional actions to mitigate the same scenario.

A potential means of mitigating these scenarios is to reinforce the distribution panels, as proposed in SAMA 37 for panels 1A/B/C/DJ481. Given that the ER lists cost of implementation as $500,000, this SAMA would not be cost effective even if it were capable of eliminating all risk associated with %IE-SET35, as shown below:

Net Value = $112,893 - $500,000 = -$387,107

For the 95th percentile PRA sensitivity, the PACR is increased by a factor of 2.84 to $320,616, which is still less than the cost of implementation.

<u>Establish the New Internal Events Importance List RRW Review Threshold:</u>

Because the MACR has increased, the depth of the importance list review must also be increased given that lower contributors to risk correlate to higher potential averted cost-risk values. Based on the new MACR of $21,379,200, the RRW threshold value is reduced from 1.006 to 1.005, which correlates to a cost of about $106,000.

<u>Review of New Internal Events Contributors</u>

Table 5j-4 provides a review of the Level 1 events with RRW values of 1.005, which resulted in the identification of only one additional SAMA:

- SAMA RAI5j-IE1: Install a keylock switch for bypass of MSIV low level isolation logic

For ATWS events, level/power control guidance may require the operators to reduce level below -129", which normally results in closure of the MSIVs. In order to maintain the condenser as a heat sink, it is necessary to bypass the isolation logic. Given the complexity of the bypass action and the limited time that is available to perform the bypass, the reliability of the action is currently low. If the bypass action were simplified to the degree where it could be performed by manipulation of a keylock switch, the action's reliability could be improved and the ATWS contribution would be reduced.

Installation of a similar logic bypass scheme was proposed as SAMA 40 at a cost of $620,000. This implementation cost is considered to be a reasonable representation of the control change proposed for SAMA RAI5j-IE1.

Given that HCGS events at the 1.005 RRW level correlate to only $301,040 with the 95th percentile results, this type of SAMA would not be cost effective.

The Level 2 review is provided in the response to RAI 5.p.

<u>REFERENCES</u>

PSEG 1997 PSEG (Public Service Electric and Gas Company). 1997. *Hope Creek Generating Station Individual Plant Examination of External Events.* July.

5.k Table E.5-3 includes 23 Phase 1 SAMAs numbered from 1 through 40. The missing numbers were presumably identified early in the process and discarded for some reason. Provide further information on the development of the Phase 1 SAMA list, the numbering of the SAMA candidates, and any candidates screened out prior to this list.

<u>PSEG Response:</u>

An importance list was initially reviewed for identification of SAMAs using the HC108A model, but after the development of the HC108B PRA model, a new importance list was reviewed and certain SAMAs that were previously identified using the HC108A model were found to either no longer be applicable or were subsumed into other existing SAMAs. However, the SAMAs were not renumbered so as to avoid any configuration errors with other documentation and supplemental files, such as those used for calculating the SAMA implementation costs and averted cost-risks. SAMAs that were identified as a result of the external events review were given a starting number of 30 so as to avoid any possible overlap with the numbers used for SAMAs identified during the internal events review.

5.l It appears that the SAMA identification process eliminated many potential SAMAs by not explicitly considering the generic list of SAMAs included in NEI 05-01 and by using the excessive implementation cost criteria in screening the PRA importance lists (see RAI 5.f). Justify that the Phase 1 SAMA identification and screening process has produced a comprehensive and sufficiently complete set of SAMAs for consideration, given that 13 of the 23 Phase 1 SAMAs were ultimately determined to be potentially cost-beneficial.

PSEG Response:

One of the reasons that the NEI 05-01 guidance was developed was to move the industry toward a SAMA identification process that was based on plant-specific risks. The development of the guidance was initiated after the NRC review of the H.B. Robinson SAMA analysis. During this review, the NRC explicitly stated that a review of a generic SAMA list was of limited benefit; the generic SAMAs had been analyzed by multiple plants and were consistently found not to be cost beneficial. The real benefit was considered to be in the development of SAMAs generated from plant-specific risk insights. The Hope Creek SAMA identification process is consistent with this philosophy given that it is based on plant-specific risk insights from the PRA models.

In addition, the generic SAMA list provided in NEI 05-01 has no intrinsic value. The list was derived from the body of SAMAs identified from previous SAMA submittals and other industry guidance (with duplicates deleted). There is no guarantee that the list of SAMAs is in any way comprehensive or that it is even relevant to any given plant beyond the fact that it includes potential plant enhancements that may have been derived from similar plants.

If the generic NEI 05-01 SAMA list were to be explicitly evaluated in a useful manner, each of the proposed SAMAs would have to be reviewed and then modified/extrapolated to match the systems or functions of the plant under consideration; otherwise, a large majority of the SAMAs would be screened as not being relevant to the plant. Even after modifying the SAMA so that it is relevant to the plant's systems/functions, further changes would be required to ensure that the SAMA would address the spectrum of risk relevant to the plant rather than just a portion of the risk. For example, SAMA 136 from Table 13 of NEI 05-01 is a SAMA to "Enhance procedures to use alternate shutdown methods if the control room becomes uninhabitable," which are already in place at Hope Creek. If effort is not expended to consider the SAMA in the context of the plant, it would be screened as "already implemented". In order to make this SAMA relevant to Hope Creek, it would have to be modified to suggest developing procedures to address scenarios in which fires in other plant areas damage critical controls in the MCR. For these cases, procedure enhancements to allow the partial transfer of control to the alternate shutdown panel would be helpful. Obviously, SAMA 136 from Table 13 of NEI 05-01 would serve only as an idea source in a process to develop a SAMA that is relevant to the Hope Creek design, operation, and plant-specific risk factors.

As stated in Section E.5.1 of the ER, the generic SAMA list from NEI 05-01 was used as an idea source to generate SAMAs for the important contributors to Hope Creek risk. The process for developing a SAMA is essentially the same as described above, but the SAMAs to be reviewed are dictated by the PRA rather than using resources to disposition the entire contents of Table 13.

While it is true that many of the Hope Creek SAMAs were found to be cost effective, it does not imply that the original SAMA list was not comprehensive. The importance list/cutset review provides reasonable assurance that the meaningful risk contributors are addressed for the plant; while it may be possible to suggest alternate means of achieving the same goal as an existing SAMA, plant personnel expended considerable effort evaluating the Hope Creek SAMAs to meet the design and operational needs of the plant.

The response to RAI 5.f addresses the potential SAMAs related to the events that were screened on excessive implementation costs.

5.m The industry SAMA review discussed in Section 5.1.3.1 for Susquehanna Steam Electric Station (Susquehanna) indicated (under Industry Site SAMA ID 6) that HCGS already includes a SAMA to automate alignment of the portable generator. No such SAMA is included in Table E.5-3. It is further stated (under Industry Site SAMA ID 5) that auto alignment of the 480V AC portable generator is addressed by SAMA 5. While SAMA 5, Restore AC power with onsite gas turbine generator, addresses loss of AC power, the utilization of the 480V AC generator (with or without automatic alignment) could mitigate other situations and have benefits different then SAMA 5. Provide an evaluation of a SAMA to automatically align the 480V AC portable generator.

PSEG Response:

Automating the alignment of the existing 480V AC portable generator would effectively eliminate the contributions associated with generator alignment from the model. These contributions include both the independent human error probability (HEP) for alignment as well as the joint HEPs (JHEPS), which are listed below:

- DCP-XHE-PORTA
- RX-FW-ADS-POR-HV
- RX-FWR-ADS-POR
- RX-FWR-POR

In order to estimate the benefit of the auto alignment enhancement, the failure probabilities for each of these events was set to zero.

The reduction in the core damage probability, dose-risk, and offsite economic risk are relatively small, as shown below:

PRA RESULTS SUMMARY FOR AUTOMATING PORTABLE GENERATOR ALIGNMENT

	CDF	Dose-Risk	OECR
Base Value	4.44E-06	22.86	$155,055
SAMA Value	4.17E-06	22.69	$153,810
Percent Change	6.1%	0.7%	0.8%

A further breakdown of the dose-risk and OECR information is provided in the Table 5.m-1 according to release category.

The PRA results were used as input to the cost benefit calculation using the methodology documented in Section E.4 of the HCGS Environmental Report and the revised external events multiplier of 6.8 that was derived in the response to RAI 5.j. The results of this calculation are provided in the following table:

AVERTED COST-RISK FOR AUTOMATING PORTABLE GENERATOR ALIGNMENT

Unit	Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
Hope Creek	$21,379,200	$21,166,231	$212,969

Using the 95th percentile PRA results, the averted cost-risk would be $604,832.

The cost of automating the alignment of the 480V AC generator is estimated based on other industry enhancements for similar changes. TMI SAMA 1 (Exelon 2008) estimated the cost of automating the start and load of an existing, permanently installed 4KV AC generator to be $3,125,000. For HCGS, the portable generator would have to be permanently installed/housed in addition to adding the logic to perform the auto start and load function.

SAMA 1 from the Shearon Harris License Renewal Environmental Report (Progress Energy 2006) does not address auto start and load of a portable 480V AC generator, but it does include permanently mounting a 480V AC generator and the plant's hydrostatic test pump so that they could be rapidly aligned to support reactor coolant pump seal injection. The cost of implementation for Shearon Harris SAMA 1 was estimated to be $1 million.

Neither of the SAMAs identified above are exact matches for the enhancement proposed in this RAI, but they demonstrate that automating alignment of a power source and permanently mounting a 480V AC generator for rapid response represent significant monetary investments.

Assuming that automating the HCGS 480V AC generator could be performed for the lesser of these two costs, this enhancement would not be cost beneficial even when the 95th percentile PRA results are applied:

$$\text{Net Value}_{\text{95th Percentile PRA Results}} = \$604{,}832 - \$1{,}000{,}000 = -\$395{,}168$$

REFERENCES

Exelon 2008 — Exelon Generation Company, LLC (Exelon). 2008. *Applicant's Environmental Report; Operating License Renewal Stage; Three Mile Island Unit 1*. Appendix E - Severe Accident Mitigation Alternatives Analysis. January.

Progress Energy 2006 — Progress Energy. 2006. *Applicant's Environmental Report; Operating License Renewal Stage; Shearon Harris Nuclear Plant.* Appendix E – Severe Accident Mitigation Alternatives Analysis. November.

5.n Table E.5-3 indicates that SAMA 38, Enhance FWS and ADS for long-term injection, was screened out on the basis that a procedure has been implemented to address the actions associated with this SAMA. However, as discussed in Section E.5.1.7.2.2, this SAMA requires enhancement to the feedwater system (FWS), including strengthening the fire water tanks. It is not clear whether/how enhancements to the FWS have been addressed as part of the implementation of the current procedure. Provide additional discussion regarding this SAMA.

PSEG Response:

HCGS procedure HC.OP-AM.TSC-0024 does provide guidance for using the fire water system and the portable generator for long term RPV injection, as indicated in Table E.5-3 of the ER; however, the physical enhancements associated with SAMA 38 were not performed. Specifically, Section E.5.1.7.2.2 indicates that the fire water tanks may have to be reinforced to ensure that they would be available. Other enhancements might also include:

- Providing a seismically qualified storage area for the portable generator, and
- Providing a seismically qualified 24-hour fuel source (gasoline) for the portable generator.

SAMA 38 was developed based on a review of Seismic Induced Equipment Damage State SET 18 (%IE-SET18), which represents a seismically induced LOOP without any additional seismically induced equipment failures. The implication is that the fire water tanks would remain intact and that no changes to the system would be required to address %IE-SET18 (procedure HC.OP-

AM.TSC-0024 is adequate alone). Given that the high confidence, low probability of failure (HCLPF) value of the offsite power system is relatively low (0.1g PGA) compared with that of the firewater tanks (0.26g PGA), this is not unreasonable.

For the remaining scenarios, other seismically induced failures have occurred in addition to loss of offsite power. These scenarios generally represent more severe seismic events and it is assumed that the physical enhancements identified above would be required to help ensure the fire water system and portable generator would be available. For the scenarios including loss of the 120V AC distribution equipment, which the response to RAI 5.j indicates are the largest seismic contributors, SAMAs 36 and 37 are considered to be more appropriate and cost effective enhancements. This is based on the GE ABWR Technical Support Document that estimated the cost of a seismically qualified CST to be $1,000,000 (GE 1994). This estimate does not account for any costs associated with providing a seismically qualified storage area or 24-hour fuel source.

The other major contributors include failure of the 125V and 250V DC systems. HCGS currently has procedures to operate RCIC without AC or DC power, which was not credited in the seismic analysis.

In summary, the design of SAMA 38 included potential enhancements to the Fire Water System that were subsequently determined not to be required. The scenarioon which SAMA 38 is based is a low magnitude seismic event that would not challenge the fire water tanks such that the existing HCGS guidance is sufficient to mitigate the event. Enhancing the Fire Water system and the portable generator would allow them to be used to mitigate some of the more severe seismic events, but these scenarios are considered to be better addressed by other SAMAs or can be addressed by existing HCGS procedures that are currently not credited in the seismic model.

<u>REFERENCES</u>

GE 1994 GE Nuclear Energy (GE). 1994. *Technical Support Document for the ABWR.* 25A5680 Rev. 1. November.

5.o Table E.5-3 indicates that SAMA 14, Alternate room cooling for SW rooms, originated from the HCGS Level 1 importance list. Identify the basic event(s) that is the source for this SAMA. Based on the description of this SAMA – to provide alternate means of opening Torus Vent Valves – it is not clear how the SAMA relates to providing alternate room cooling for SW rooms. Explain this discrepancy. Also, this SAMA was subsumed into SAMA 4 and subsequently not retained for the Phase 2 evaluation. Clarify the logic for subsuming this SAMA into SAMA 4.

The events that were originally associated with SAMA 14 are related to containment venting failure (CAC-SOV-CC-11541 and CAC-SOV-CC-4964). The HCGS PRA model conservatively does not credit the local venting action for these types of failures; however, the action is applicable. If credit is taken for the local venting action, the cutsets including CAC-SOV-CC-11541 and CAC-SOV-CC-4964 are essentially eliminated and no SAMAs are required.

The disposition of events CAC-SOV-CC-11541 and CAC-SOV-CC-4964 evolved during the development of the SAMA analysis to address the different contributors that are linked with the CAC-SOV-CC-11541 and CAC-SOV-CC-4964 events. The approaches to dispositioning these contributors included:

- Providing an alternate room cooling strategy to address failure of the Service Water Pump Room fans (these HVAC failures result in loss of containment heat removal and ultimately require containment venting).
- Directly addressing remote vent valve failures by "proceduralizing" local operator actions.
- Mitigating the RHR failures that lead to the need to perform containment venting (loss of RHR requires containment venting as an alternate heat removal strategy). These RHR failures are linked to event RHS-REPAIR-TR, which is included in all cutsets containing events CAC-SOV-CC-11541 and CAC-SOV-CC-4964. SAMA 4 was developed to address event RHS-REPAIR-TR.

The title of SAMA 14, as documented in Table E.5-3 of the ER, is "Alternate room cooling for SW Rooms". This title was based on the strategy to address the Service Water Pump Room HVAC fan failures. The approach was to use portable fans to provide alternate room cooling.

The description of SAMA 14, which was not updated to match the title in Table E.5-3 of the ER, is "Provide an alternate means of opening the Torus vent valves when remote operation fails. Adequate time is available given this is a long term sequence." This description was based on the strategy to address the vent valve failures with procedures for the local venting action.

As the SAMA analysis progressed, it was decided that SAMA 4 was the most appropriate means of addressing the scenarios including events CAC-SOV-CC-11541 and CAC-SOV-CC-4964. Table E.5-1 was updated to reflect this, but SAMA 14 was retained in Table E.5-3 with a comment that it had been subsumed by SAMA 4.

There are other contributors to Service Water Pump Room HVAC failures, however, that could be addressed by an alternate room cooling strategy. SAMAs 17 and 18 represent potential enhancements to mitigate these contributors that were determined to be cost effective, but implementation of an alternate room cooling strategy similar to what is in place for the Switchgear Rooms may be a more practical and cost effective solution. This is addressed in the response to RAI 7.a.

In summary, SAMA 4 is directly related to events CAC-SOV-CC-11541 and CAC-SOV-CC-4964 and providing procedures to direct inter-train RHR cross-tie could potentially provide some benefit in the relevant failure sequences. However, a more complete approach to dispositioning these events would have been to clarify that the HCGS local venting procedures already address the SOV failures and that no additional SAMAs are required. The remaining contributors to Service Water Pump Room HVAC can be addressed by an alternate room cooling strategy and an evaluation of this enhancement is provide in the response to RAI 7.a.

5.p Section E.5.1.2 implies that Table E.5-2 provides the large early release probability (LERF) (release category H/E) basic events having a risk reduction worth (RRW) greater than or equal to 1.006. This section also states that a review of cutsets from all non-intact release categories was performed, however results of that review are not presented. Given that non-LERF release categories dominate the population dose-risk (i.e., H/I, M/E, and M/I), provide documentation of Public Service Electric & Gas Co. (PSEGs) review of potential SAMAs for the risk-dominant non-intact release categories (e.g., a listing of the basic events having a RRW greater than or equal to 1.006, the applicable SAMA(s) for each of the events, and an evaluation of any new SAMAs.

PSEG Response:

The introductory sentence in Section E.5.1 of the ER states that the cutsets representing "LERF" were reviewed to determine if any potential SAMA candidates were feasible; however, the sentences should have stated that the cutsets representing all Level 2 release categories were reviewed.

While all Level 2 release categories were reviewed, the review failed to exclude the "intact" and "low" release categories. These release categories have relatively high frequencies with low consequences. In order to prevent these release categories from dominating the importance list, the Level 2 importance review has been revisited using only the cutsets from the "high" and "moderate" release categories.

Based on the evaluations performed in the response to RAI 5.j, the importance list review threshold has been lowered from the 1.006 level documented in the ER to 1.005 (includes more events for review to account for a larger seismic contribution).

Table 5.p-1 provides a review of the Level 2 events down to the threshold of 1.005, which resulted in the identification of two additional SAMAs:

- SAMA RAI5j-IE1: Install a keylock switch for bypass of MSIV low level isolation logic

- SAMA RAI5p-1: Install an independent boron injection system

SAMA RAI5j-IE1 is evaluated in the response to RAI 5.j. SAMA RAI5p-1 is evaluated below.

SAMA RAI5p-1

In order to provide a means of mitigating instances in which the SLC tank boron concentration level is out of the required limits, a separate SLC tank that is monitored and maintained independently from the existing tank would be required. In addition, because the timing of SLC injection is critical, an independent pump train would be required to ensure that the liquid poison is delivered to the RPV in a timely manner (simultaneously with the existing system).

In order to model the installation of an independent SLC system, the SLC system logic has been "AND"ed with an undeveloped event representing the independent SLC system hardware failures (failure probability of 1.0E-03). It was assumed that the independent SLC train is powered by the same 480V MCC as SLC pump AP208 (10B212) and this power dependency was added to the logic.

The reduction in the core damage probability, dose-risk, and offsite economic risk are relatively small, as shown below:

PRA RESULTS SUMMARY FOR INDEPENDENT SLC TRAIN

	CDF	Dose-Risk	OECR
Base Value	4.44E-06	22.86	$155,055
SAMA Value	4.41E-06	22.42	$152,144
Percent Change	0.7%	1.9%	1.9%

A further breakdown of the dose-risk and OECR information is provided in the Table 5.p-2 according to release category.

The PRA results were used as input to the cost benefit calculation using the methodology documented in Section E.4 of the HCGS Environmental Report and the revised external events multiplier of 6.8 that was derived in the response to RAI 5.j. The results of this calculation are provided in the following table:

AVERTED COST-RISK FOR INDEPENDENT SLC TRAIN			
Unit	**Base Case Cost-Risk**	**Revised Cost-Risk**	**Averted Cost-Risk**
Hope Creek	$21,379,200	$20,984,616	$394,584

With regard to the cost of implementation, Browns Ferry estimated the cost of installing a redundant train of SLC to be $1,000,000 (TVA 2003). In order to account for the requirement to install an additional SLC tank and to maintain it a manner that is independent of the existing tank, the cost of implementation has been increased by 50 percent to $1.5 million.

The net value of the change proposed in this RAI is the difference between the averted cost-risk and the cost of implementation:

Net Value = $394,584 - $1,500,000 = -$1,105,416

The large, negative net value indicates that this SAMA is not cost beneficial. Even if the 95th percentile PRA results are used in conjunction with an external events multiplier of 6.8, the net value is still negative:

$\text{Net Value}_{\text{95th percentile PRA Results}} = (\$394{,}584 * 2.84) - \$1{,}500{,}000 = -\$379{,}381$

REFERENCES

TVA 2003 Tennessee Valley Authority (TVA). 2003. *Applicant's Environmental Report; Operating License Renewal Stage; Browns Ferry Nuclear Power Plant, Units 1, 2, and 3.* Attachment E-4, Severe Accident Mitigation Alternatives at the Browns Ferry Nuclear Plant, Volume I of III. Application for Renewed Operating Licenses. December.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
CGS-PHE-FF-INERT	9.90E-01	6.244	CONTAINMENT INERTED; VENTING NOT REQUIRED	Y	
RX-NOCREDIT	1.00E+00	3.513	FAILURE OF IN-VESSEL RECOVERY	Y	
CNT-MDL-FF-SCTRM	1.00E+00	2.755	REACTOR BUILDING INEFFECTIVE IN REDUCING SOURCE TERM	Y	
CNT-MDL-FF-LVL1F	1.00E+00	2.153	LG CONT. FAILURE GIVEN CONT. FAILED IN LEVEL 1 (CLASS II, IIID, IV)	Y	
CNT-DWV-FF-MLTFL	1.00E+00	2.124	DW SHELL MELT-THROUGH FAILURE DUE TO CONT. FAILURE	Y	
DIA	9.78E-01	1.746	DRYWELL FAILURE (CLASS IIA)	Y	
OP6-IIA-NOT	8.80E-01	1.6	RPV DEPRESSURIZATION SUCCESSFUL (IIA)	Y	
RHS-REPAIR-TR	3.50E-01	1.592	REPAIR/RECOVERY OF RHR FOR LOSS OF DHR EVENTS (TRANSIENT EVENTS)	N	Not addressed in Table E.5-2 of the ER, but it was addressed in Table E.5-1. No additional SAMAs required.
ADS-XHE-OK-INHIB	1.00E+00	1.285	OPERATOR SUCCESSFULLY INHIBITS ADS WITH NO HP INJECTION (NON-ATWS)	N	Not addressed in Table E.5-2 of the ER, but it was addressed in Table E.5-1. No additional SAMAs required.
%IE-SWS	1.79E-04	1.27	LOSS OF SERVICE WATER INITIATING EVENT	N	Not explicitly addressed in the Tables E.5-1 or E.5-2 of the ER, but this initiating event it is tied directly to event NR-IE-SWS, which was addressed in Table E.5-1 of the ER. The response to RAI 5b discusses the disposition of NR-IE-SWS with SAMAs 1, 4, 15, and credit for local valve operation.
NR-IE-SWS	1.00E+00	1.27	NONRECOVERY OF %IE-SWS	N	This event was addressed in Table E.5-1 of the ER. The response to RAI 5b discusses the disposition of NR-IE-SWS with SAMAs 1, 4, 15, and credit for local valve operation.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
%IE-TE	2.37E-02	1.221	LOSS OF OFFSITE POWER INITIATING EVENT	N	Not addressed in Table E.5-2 of the ER, but it was addressed in Table E.5-1. No additional SAMAs required.
LOOP-IE-SW	2.10E-01	1.189	COND. PROBABILITY DUE TO WEATHER RELATED LOOP EVENT	N	Not addressed in Table E.5-2 of the ER, but it was addressed in Table E.5-1. No additional SAMAs required.
FC5-3B-NOT	5.90E-01	1.161	CONTAINMENT FLOODING INITIATED (IIIB)	N	The event was included, but no SAMA was identified. Over 80% of the contribution is driven by failure to depressurize, which is addressed by SAMA 1. No additional SAMAs required.
NR-U1X-DEP-SRV	3.00E-04	1.139	FAILURE TO DEPRESSURIZE WITH SRV W/O HIGH PRES. INJ.	N	Not addressed in Table E.5-2 of the ER, but it was addressed in Table E.5-1. No additional SAMAs required.
OSPR20HR-SW	1.33E-01	1.128	FAILURE TO RECOVER OSP WITHIN 20 HRS (SW RELATED LOOP EVENT)	N	Not addressed in Table E.5-2 of the ER, but it was addressed in Table E.5-1. No additional SAMAs required.
1RXRX-ONEACL-F--	1.00E+00	1.123	ONSITE EMERGENCY AC POWER NOT RECOVERED	Y	
OP5-NOT	8.80E-01	1.12	RPV DEPRESSURIZATION SUCCESSFUL	N	The event was included, but no SAMA was identified. Over 99.9% of the scenarios including this event include failure to restore onsite AC power. SAMA 5 would address most of these cases.
1RXRX-OFFACL-F--	6.00E-01	1.12	OFFSITE AC POWER NOT RECOVERED	Y	
%IE-MS	1.46E+00	1.12	MANUAL SHUTDOWN INITIATING EVENT	N	The event was included in Table E.5-1, but no SAMA was identified. The response to RAI 5a identifies that this initiating event includes a diverse set of contributors that are addressed by several SAMAs, including (1, 4, 16, 17, and 18). No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
%IE-TT	7.03E-01	1.111	TURBINE TRIP WITH BYPASS	N	Not addressed in Table E.5-2 of the ER, and no specific SAMA was identified for the event in Table E.5-1. The response to RAI 5a identifies that this initiating event includes a diverse set of contributors that are addressed by several SAMAs, including (1, 17, and 18). No additional SAMAs required.
%IE-S2-WA	6.20E-04	1.108	SMALL LOCA - WATER (BELOW TAF)	N	Not addressed in Table E.5-2 of the ER, and no specific SAMA was identified for the event in Table E.5-1. The response to RAI 5a identifies that the contributors including this initiating event are addressed by SAMA 1. No additional SAMAs required.
NR-S1X-DEP-SRV	3.20E-02	1.104	FAILURE TO MAN. DEPRESS. FOR A MED. LOCA W/NO HI PRESS. INJ.	N	Not addressed in Table E.5-2 of the ER, and no specific SAMA was identified for the event in Table E.5-1. The contributors including this event are addressed by SAMA 1. No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
1OPPH-PRESBK-F--	8.00E-01	1.098	PRESSURE TRANSIENT DOES NOT FAIL MECHANICAL SYSTEMS	N	The event was included in Table E.5-2, but no SAMA was identified. About 32% of the contribution is related to remote failures of valves HV-4964 or HV-11541. The PRA model conservatively does not credit the local venting action to bypass these failures, but the action is applicable. An additional 23% of the contributors conservatively do not credit local containment vent in long term SBO scenarios with portable generator and diesel fire injection success, but again, local venting is applicable. About 10% of the remaining diverse set of contributors can be addressed by simplifying the alignment of the gas turbine (SAMA 5). No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
1OPPH-SORV---F--	5.50E-01	1.098	SRVs DO NOT FAIL OPEN DURING CORE MELT PROGRESSION	N	The event was included in Table E.5-2, but no SAMA was identified. About 32% of the contribution is related to remote failures of valves HV-4964 or HV-11541. The PRA model conservatively does not credit the local venting action to bypass these failures, but the action is applicable. An additional 23% of the contributors conservatively do not credit local containment vent in long term SBO scenarios with portable generator and diesel fire injection success, but again, local venting is applicable. About 10% of the remaining diverse set of contributors can be addressed by simplifying the alignment of the gas turbine (SAMA 5). No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
1OPPH-TEMPBK-F--	7.00E-01	1.098	HIGH PRIM SYS TEMP DOES NOT CAUSE FAIL OF RCS PRESS. BOUND	N	The event was included in Table E.5-2, but no SAMA was identified. About 32% of the contribution is related to remote failures of valves HV-4964 or HV-11541. The PRA model conservatively does not credit the local venting action to bypass these failures, but the action is applicable. An additional 23% of the contributors conservatively do not credit local containment vent in long term SBO scenarios with portable generator and diesel fire injection success, but again, local venting is applicable. About 10% of the remaining diverse set of contributors can be addressed by simplifying the alignment of the gas turbine (SAMA 5). No additional SAMAs required.
OP--XHE-ALT-DEP	1.00E+00	1.098	ALTERNATE DEPRESS. METHODS NOT CREDITED	Y	The event was included in Table E.5-2, and SAMA 4 was suggested. The recovery of heat removal is a large contributor for these cases and providing RHR X-tie guidance could potentially address these scenarios. However, this event is included in the same scenarios as events 1OPPH-TEMPBK-F--, 1OPPH-PRESBK-F--, and 1OPPH-SORV---F-- and the same insights are applicable. No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
DW-SHELL-RUPT	4.50E-01	1.097	DRYWELL SHELL RUPTURE DISRUPTS INJECTION LINES AND FAILS RB SYS	N	The event was included in Table E.5-1, but no SAMA was identified. Over 30% of the contributors include failure of the SACS HX bypass valves or the temperature controllers that govern the valves. An additional 8.5% of the contributors containing the event are remote vent failures that are binned to core damage without crediting local containment venting. If the PRA model included credit for the existing procedures and training address these failures, they would no longer be significant contributors. Most of the remaining contribution comes from scenarios in which the plant hardware operates adequately and the operator action failures are very low. Enhancements that require additional operator action would have very limited benefit due to dependence issues and limitations on operator credit in a single scenario. A passive containment vent is a potential option, but as described in the response to RAI 5.d, it is undesirable from an operations perspective and may provide no net risk reduction. No additional SAMAs suggested.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
SAC-XHE-MC-DF01	8.00E-05	1.092	DEPENDENT FAILURE OF MISCAL. OF TEMP CONTROLLER HV-2457S	N	The event was included in Table E.5-1, but no SAMA was identified. About 40% of the contributors containing the event are binned to core damage without crediting local containment venting. If this action is credited, these scenarios are no longer important contributors. If existing procedures are credited to address failures of the HV-2457S temperature controller, the remaining contributors would also be eliminated. No additional SAMAs required.
%IE-S2-ST	6.20E-04	1.08	SMALL LOCA - STEAM (ABOVE TAF)	N	The event was included in Table E.5-1, but no SAMA was identified. 80% of the contribution is addressed by SAMA 1. No additional SAMAs required.
DIATWS-NOT	9.90E-01	1.079	DW INTACT ATWS	N	The event was included in Table E.5-2, but no SAMA was identified. About 30% of the contributors include failure to bypass the low level MSIV isolation logic. This SAMA is identified and evaluated in the response to RAI 5j (SAMA RAI5j-IE1). Over 50% of the contribution is related to failure to control level early. Given the availability of auto-SLC and that the operators are well trained on ATWS scenarios, no further enhancements had been identified to address these ATWS events.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
RPCDRPS-MECHFCC	2.10E-06	1.074	MECHANICAL SCRAM FAILURE	N	The event was included in Table E.5-2, but no SAMA was identified. About 30% of the contributors include failure to bypass the low level MSIV isolation logic. This SAMA is identified and evaluated in the response to RAI 5j (SAMA RAI5j-IE1). Over 50% of the contribution is related to failure to control level early. Given the availability of auto-SLC and that the operators are well trained on ATWS scenarios, no further enhancements had been identified to address these ATWS events.
RHS-REPAIR-L	4.30E-01	1.074	REPAIR/RECOVERY OF RHR FOR LOSS OF DHR EVENTS (LOCA EVENTS)	N	Not addressed in Table E.5-2 of the ER, but it was addressed in Table E.5-1. SAMA 4 was proposed as a means of improving the heat removal recovery process by proceduralizing the cross-tie between RHR trains. Separately, about 37% of the contributors are related to ECCS suction strainer clogging, which could be mitigated with SAMA 15. No additional SAMAs required.

Table 5.p-1

DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
OP6-NOT	9.00E-01	1.07	RPV DEPRESSURIZATION SUCCESSFUL	N	The event was included in Table E.5-2, but no SAMA was identified. About 30% of the contributors include failure to bypass the low level MSIV isolation logic. This SAMA is identified and evaluated in the response to RAI 5.j (SAMA RAI5j-IE1). An additional 37% of the contribution is related to failure to control level early. Given the availability of auto-SLC and that the operators are well trained on ATWS scenarios, no further enhancements had been identified to address these ATWS events.
CND-SYS-FF-LERF	1.00E+00	1.07	CONDITIONAL PROBABILITY OF CLASS V SEQUENCE RESULTING IN LERF	N	The event was included in Table E.5-2, but no SAMA was identified. 85% of the contribution is addressed by SAMA 1. No additional SAMAs required.
CAC-AOV-CC-11541	1.11E-03	1.066	PNUEMATIC SUPPLY TO HV-11541 FAILS	N	This event was addressed in Table E.5-1, but SAMA 4 was identified as a means of mitigating the contributors including this event. Given that the existing local containment venting procedures address this failure, no SAMAs are required.
CAC-AOV-CC-4964	1.11E-03	1.066	PNEUMATIC SUPPLY TO HV-4964 FAILS	N	This event was addressed in Table E.5-1, but SAMA 4 was identified as a means of mitigating the contributors including this event. Given that the existing local containment venting procedures address this failure, no SAMAs are required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
1OPPH-CNTFAD-F--	4.50E-01	1.065	STRUCTURAL BREACH IN CONT. CUASES FAILURE OF ADS	N	The event was included in Table E.5-2, but no SAMA was identified. About 50% of the contribution could be mitigated if existing local venting procedures are credited. An additional 25% may be addressed by improving the RHR cross-tie capabilities (SAMA 4). No additional SAMAs required.
QUVISL	1.00E+00	1.061	ALTERNATE MAKEUP SOURCES INADEQUATE (ISLOCA)	N	The event was appropriately addressed in Table E.5-1. No additional SAMAs required.
CAC-XHE-FO-LVENT	6.20E-02	1.061	LOCAL VENTING THRU 12" LINE FAILS	N	The event was included in Table E.5-1 and addressed by SAMA 4. No additional SAMAs required.
VISL	1.00E+00	1.061	LOW PRESSURE MAKEUP UNAVAILABLE (ISLOCA)	N	The event was included in Table E.5-1 and addressed by SAMA 1. No additional SAMAs required.
UISLOCA	1.00E+00	1.059	HPCI/RCIC UNAVAILABLE FOR ISLOCA (LARGE RUPTURE OR NO EARLY ISOLATION)	N	The event was included in Table E.5-1 and addressed by SAMA 1. No additional SAMAs required.
%IE-ISLOCAD	1.63E-05	1.059	ISLOCA INITIATOR FOR ECCS DISCHARGE PATHS	N	The event was included in Table E.5-1, but no SAMA was identified. Over 98% of the contributors include failure to depressurize the RPV, which would be mitigated by SAMA 1. No additional SAMAs required.
IS1L	4.20E-01	1.058	SYSTEM ISOLATION FAILS GIVEN LEAKAGE	N	The event was included in Table E.5-1, but no SAMA was identified. Over 99% of the contributors include failure to depressurize the RPV, which would be mitigated by SAMA 1. No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
LEAKD	5.00E-01	1.058	PIPE LEAKAGE GIVEN OVERPRESSURIZATION IN SDC DISCHARGE LINES	N	The event was included in Table E.5-1, but no SAMA was identified. Over 99% of the contributors include failure to depressurize the RPV, which would be mitigated by SAMA 1. No additional SAMAs required.
1RXPH-CRDINJ-F--	1.00E+00	1.057	CRD INJECTION INADEQUATE	Y	The event was included and dispositioned with SAMA 1 in Table E.5-2, but other SAMAs are considered to be more applicable. About 30% of the contributors are related to Fire Protection system floods that could be addressed by SAMA 8. An additional 25% may be addressed by SAMA 7 and another 35% may be addressed by SAMA 4. No additional SAMAs required.
1RXPH-HPCIRVLF--	1.00E+00	1.057	HPCI UNAVAILABLE	Y	The event was included and dispositioned with SAMA 1 in Table E.5-2, but other SAMAs are considered to be more applicable. About 30% of the contributors are related to Fire Protection system floods that could be addressed by SAMA 8. An additional 25% may be addressed by SAMA 7 and another 35% may be addressed by SAMA 4. No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
1RXPH-MNFDWTRF--	1.00E+00	1.057	MAIN FEEDWATER SYSTEM UNAVAILABLE	Y	The event was included and dispositioned with SAMA 1 in Table E.5-2, but other SAMAs are considered to be more applicable. About 30% of the contributors are related to Fire Protection system floods that could be addressed by SAMA 8. An additional 25% may be addressed by SAMA 7 and another 35% may be addressed by SAMA 4. No additional SAMAs required.
1RXPH-RCICINAF--	1.00E+00	1.057	RCIC SYSTEM INADEQUATE	Y	The event was included and dispositioned with SAMA 1 in Table E.5-2, but other SAMAs are considered to be more applicable. About 30% of the contributors are related to Fire Protection system floods that could be addressed by SAMA 8. An additional 25% may be addressed by SAMA 7 and another 35% may be addressed by SAMA 4. No additional SAMAs required.
VF--XHE-L2-INREC	9.00E-01	1.057	OPERATOR FAIL TO RECOVER INJECTION BEFORE RPV BREACH	Y	The event was included and dispositioned with SAMA 1 in Table E.5-2 and is addressed by SAMAs 7 and 8. SAMA 4 may also provide some benefit.
CAC-SOV-CC-11541	9.54E-04	1.055	SOLENOID VALVE SV-11541 FAILS TO OPEN.	N	This event was addressed in Table E.5-1, but SAMA 4 was identified as a means of mitigating the contributors including this event. Given that the existing local containment venting procedures address this failure, no SAMAs are required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
CAC-SOV-CC-4964	9.54E-04	1.055	SOLENOID VALVE 4964 FAILS TO OPEN.	N	This event was addressed in Table E.5-1, but SAMA 4 was identified as a means of mitigating the contributors including this event. Given that the existing local containment venting procedures address this failure, no SAMAs are required.
L2-OSP-24H-SW	8.57E-01	1.055	COND PROB OF FAILURE TO RESTORE AC IN L2 W/IN 24 HRS. NODE SI	Y	
IS1-IA-NOT	8.00E-01	1.052	CONTAINMENT ISOLATION SUCCESSFUL (IA)	N	The event was included in Table E.5-2, but no SAMA was identified. About 60% of the contributors are addressed by SAMAs 7 and 8. An additional 30% may be addressed by improving the RHR cross-tie capabilities (SAMA 4). No additional SAMAs required.
RHR-MCU-FF-MSIVS	1.00E+00	1.048	PCS UNAVAILABLE AS HEAT SINK	Y	In addition to SAMA 4, about 50% of the contributors could be addressed by SAMAs 7 and 8. No additional SAMAs required.
RHR-MDL-FF-EOPCM	1.00E+00	1.048	CONTINGENCY METHODS INADEQUATE (NOT CREDITED)	Y	In addition to SAMA 4, about 50% of the contributors could be addressed by SAMAs 7 and 8. No additional SAMAs required.
CIS-DRAN-L2-OPEN	1.00E+00	1.048	VALVES OPEN AUTOMATICALLY FOR DRAINAGE NORMALLY OPEN	Y	Also, refer to the response to RAI 5.i for additional information pertaining to the disposition of this event. No additional SAMAs required.
OSPR7HR-SW	2.80E-01	1.044	FAILURE TO RECOVER OSP WITHIN 7 HRS (SW RELATED LOOP EVENT)	N	This event was addressed in Table E.5-1 with SAMA 10. SAMA 5 is also applicable. No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
PCS-SYS-RP-DWFAIL	4.30E-01	1.043	LARGE DW CONTAINMENT FAILURE CAUSES LOSS OF INJECTION	N	The event was included in Table E.5-2, but no SAMA was identified. About 50% of the contributors are related to FPS and RACS room flooding events and they are addressed by SAMAs 7 and 8. Most of the remaining contributors include Core Spray suction strainer clogging, which is addressed by SAMA 15. No additional SAMAs required.
CNT-MDL-SC-MDTMP	1.00E+00	1.043	SM CONT. FAILURE AT INTER DW TEMP. (CLASS I, III WITH RPV BREACH)	N	The event was included in Table E.5-2, but no SAMA was identified. About 50% of the contributors are related to FPS and RACS room flooding events and they are addressed by SAMAs 7 and 8. Most of the remaining contributors include Core Spray suction strainer clogging, which is addressed by SAMA 15. No additional SAMAs required.
NR-VENT-5-03	4.10E-04	1.04	FAILURE TO INITIATE CONT. VENT. GIVEN SPC HARDWARE FAILURE	N	This event was addressed in Table E.5-1 with SAMA 4; however, about 25% of the contributors are related to failure of temp controller HV-2457S or AOV 2457A. These failures are addressed by existing procedures, but the local operation of the valve is not credited. An additional 20% of the contribution is related to SW pump room HVAC failures, which are addressed by SAMAs 17 and 18. No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
SLC-XHE-E-LVL	4.60E-01	1.039	FAIL TO CONTROL LEVEL EARLY DURING ATWS SEQUENCE	N	The event was included in Table E.5-1, but no SAMA was identified. About 30% of the contributors include failure to bypass the low level MSIV isolation logic. This SAMA is identified and evaluated in the response to RAI 5.j (SAMA RAI5j-IE1). Given the availability of auto-SLC and that the operators are well trained on ATWS scenarios, no further enhancements had been identified to address these ATWS events.
WWATWS	5.00E-01	1.038	WW FAILURE ATWS	N	The event was included in Table E.5-2, but no SAMA was identified. About 30% of the contributors include failure to bypass the low level MSIV isolation logic. This SAMA is identified and evaluated in the response to RAI 5.j (SAMA RAI5j-IE1). Given the availability of auto-SLC and that the operators are well trained on ATWS scenarios, no further enhancements had been identified to address these ATWS events.
WWATWS-NOT	5.00E-01	1.038	WW FAILURE ATWS	N	The event was included in Table E.5-2, but no SAMA was identified. About 30% of the contributors include failure to bypass the low level MSIV isolation logic. This SAMA is identified and evaluated in the response to RAI 5.j (SAMA RAI5j-IE1). Given the availability of auto-SLC and that the operators are well trained on ATWS scenarios, no further enhancements had been identified to address these ATWS events.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
NR-RHR-INIT-L	2.10E-06	1.037	FAILURE TO INITIATE RHR FOR DECAY HEAT REMOVAL WITHIN 20 HRS	N	The event was included in Table E.5-1, but no SAMA was identified. Most of the contribution comes from scenarios in which the plant hardware operates adequately and the operator actions failures are very low. Enhancements that require additional operator action would have very limited benefit due to dependence issues and limitations on operator credit in a single scenario. A passive containment vent is a potential option, but as described in the response to RAI 5.d, it is undesirable from an operations perspective and may provide no net risk reduction. No SAMAs suggested.
NR-RHRVENT-INIT	2.40E-01	1.037	FAIL TO INITIATE VENT GIVEN FAILURE TO INITIATE RHR IN SPC	N	The event was included in Table E.5-1, but no SAMA was identified. Most of the contribution comes from scenarios in which the plant hardware operates adequately and the operator actions failures are very low. Enhancements that require additional operator action would have very limited benefit due to dependence issues and limitations on operator credit in a single scenario. A passive containment vent is a potential option, but as described in the response to RAI 5.d, it is undesirable from an operations perspective and may provide no net risk reduction. No SAMAs suggested.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
OSPR4HR-SW	3.61E-01	1.036	FAILURE TO RECOVER OFFSITE POWER WITHIN 4.5 HRS (SW RELATED EVENT)	N	This event was addressed in Table E.5-1 with SAMA 5. No additional SAMAs required.
NR-XTIE-EDG	1.00E+00	1.034	FAILURE TO CROSS-TIE DIESEL GENERATOR	N	This event was addressed in Table E.5-1 with SAMA 5. No additional SAMAs required.
VIS-FAN-FS-DF01	1.08E-05	1.033	CCF FAILURE FANS A THRU DV503 FAIL TO START	N	This event was addressed in Table E.5-1 with SAMA 17. Also, refer to the response to RAI 7.a.
VIS-FAN-FS-DF12	1.08E-05	1.033	CCF FAILURE FANS A THRU DV504 FAIL TO START	N	This event was addressed in Table E.5-1 with SAMA 18. Also, refer to the response to RAI 7.a.
L2-OSP-11H-SW	7.46E-01	1.031	COND. PROB. OF FAILURE TO RESTORE AC IN L2 W/IN 11 HRS IN NODE SI	Y	
RPT-PIP-RP-SEALS	9.50E-01	1.03	COND. PROB. OF SMALL RECIRC SEAL LOCA GIVEN SBO	N	This event was included in Table E.5-1, but not linked with any SAMA. Over 50% of the contributors including this event are related to failure of the SACS Hx Bypass valves or the temperature controller for the valves (leads to SBO in a LOOP). If credit is taken for existing procedures and training, these contributors would effectively be eliminated. The remaining contributors are addressed by SAMA 5. No additional SAMAs required.
VIS-FAN-FR-DF01	9.90E-06	1.03	CCF FAILURE FANS A THRU DV503 FAIL TO RUN	N	This event was addressed in Table E.5-1 with SAMA 17. Also, refer to the response to RAI 7.a.
VIS-FAN-FR-DF12	9.90E-06	1.03	CCF FAILURE FANS A THRU DV504 FAIL TO RUN	N	This event was addressed in Table E.5-1 with SAMA 18. Also, refer to the response to RAI 7.a.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
%IE-TC	9.33E-02	1.029	LOSS OF CONDENSER VACUUM	N	The event was included in Table E.5-1, but no SAMA was identified. Most of the contribution comes from loss of CHR scenarios in which the plant hardware operates adequately and the HEPs are very low. For the ATWS level control failures, the HEPs are not as low, but the operators are well trained and SLC functions properly. For loss of CHR, enhancements that require additional operator action would have very limited benefit due to dependence issues and limitations on operator credit in a single scenario. A passive containment vent is a potential option, but as described in the response to RAI 5.d, it is undesirable from an operations perspective and may provide no net risk reduction. No SAMAs suggested.
CGS-PHE-FF-STMIN	9.90E-01	1.028	COMBUSTIBILE GAS VENTING NOT REQUIRED (STEAM INERTED - CLASS IIID)	N	The event was included in Table E.5-2, but no SAMA was identified. Over 88% of the contributors include failure to depressurize, which are addressed by SAMA 1. No additional SAMAs required.
DIT	1.00E+00	1.028	DRYWELL FAILURE (CLASS IIT AND IIID)	N	The event was included in Table E.5-2, but no SAMA was identified. Over 88% of the contributors include failure to depressurize, which are addressed by SAMA 1. No additional SAMAs required.
L2-OSP-8H-SW	6.75E-01	1.028	COND. PROB. OF FAILURE TO RESTORE AC IN L2 W/IN 8 HRS IN NODE SI	Y	

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
CGS-XHE-L2-VENT	2.51E-01	1.027	OPERATOR FAILS TO VENT (HC.OP.EO-ZZ.0318)	Y	
ACP-XHE-L2-OP	5.00E-01	1.027	OPERATOR FAILS TO RESTORE AC POWER DURING BOIL-OFF	Y	
CIS-XHE-FO-DRN-E	1.00E+00	1.026	OP FAILS TO LOCALLY CLOSE EQ. DRN AND FLR DRN MOV IN RB-EARLY	Y	Also, refer to the response to RAI 5.i for additional information pertaining to the disposition of this event. No additional SAMAs required.
1RXRX-OFFACE-F--	6.30E-01	1.025	OFFSITE AC POWER NOT RECOVERED	Y	
1RXRX-ONEACE-F--	1.00E+00	1.025	ONSITE EMERGENCY AC POWER NOT RECOVERED	Y	
NR-CSC-VSS-INIT	3.90E-02	1.025	OPERATOR FAILS TO INITIATE DRYWELL SPRAYS	Y	
UV1-XHE-ALDHR-RX	1.00E+00	1.024	Op. Fails to Align Alternate Inj. Flow Paths to Recover In-Vessel Core Damage	Y	
CAC-LOG-NO-AC652	3.33E-03	1.024	LOGIC CIRCUIT AT AC652 FAILS.	Y	This event was addressed by SAMA 4 in Table E.5-2. It should be noted, however, that the PRA model conservatively does not credit the local venting action to bypass CAC-LOG-NO-AC652. If credit is taken, this event would no longer be a significant contributor. No additional SAMAs required.
CAC-LOG-NO-DC652	3.33E-03	1.024	LOGIC CIRCUIT TO HV-4978 FAILS.	Y	This event was addressed by SAMA 4 in Table E.5-2. It should be noted, however, that the PRA model conservatively does not credit the local venting action to bypass CAC-LOG-NO-DC652. If credit is taken, this event would no longer be a significant contributor. No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
CIS-XHE-FO-DRN-L	1.30E-01	1.022	OP FAILS TO LOCALLY CLOSE EQ. DRN AND FLR DRN MOV IN RB-LATE	Y	Also, refer to the response to RAI 5.i for additional information pertaining to the disposition of this event. No additional SAMAs required.
SAC-AOV-OO-DF01	2.26E-05	1.022	CCF FAILURE OF HV-2457A AND B VALVES	N	This event was included in Table E.5-1, but no SAMA was identified. HCGS has procedure that would direct local operation of these valves, but the PRA conservatively does not credit the action. If credit is taken, they are no longer significant contributors. No additional SAMAs required.
MSOP-LVL1--H--	5.00E-01	1.022	RPV WATER LEVEL REQUIRED TO BE LOWERED BELOW LEVEL 1	N	This event was included in Table E.5-1, but no SAMA was identified. MSOP-LVL1--H-- is completely tied to MSOPMSIVINLKH--, which could be mitigated by installing a keylock switch to bypass the low level MSIV isolation logic (refer to the response to RAI 5.j for the evaluation of this SAMA).
MSOPMSIVINLKH--	9.20E-01	1.022	FAIL TO BYPASS THE LOW LEVEL INTERLOCK AT LVL 1 (-129")	N	This event was included in Table E.5-1, but no SAMA was identified. MSOPMSIVINLKH-- could be mitigated by installing a keylock switch to bypass the low level MSIV isolation logic (refer to the response to RAI 5.j for the evaluation of this SAMA).
SWS-PHE-PMP-HD	9.00E-01	1.021	SW HEAD INADEQUATE	Y	

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
SLC-XHE-L-LVLCND	3.91E-02	1.02	LATE RPV WATER LEVEL CONTROL (CONDITIONAL)	N	The event was included in Table E.5-2, but no SAMA was identified. The scenarios including this event are primarily ATWS scenarios in which SLC has been successfully initiated and no other hardware failures occur apart from the initial failure to scram. In these cases, operator action is required to adequately control level, which is a well trained scenario. As a reliable automated ATWS level control system has not been identified, no SAMAs are suggested.
L2-OSP-10H-SW	7.26E-01	1.019	COND PROB OF FAILURE TO RESTORE AC IN L2 W/IN 10 HRS IN NODE SI	Y	
OSP65HR-SW	3.07E-01	1.019	FAILURE TO RECOVER OSP WITHIN 6 HOURS (SEVERE WEATHER LOOP EVENT)	Y	
%IE-SACS	1.16E-04	1.018	LOSS OF SACS INITIATING EVENT	N	This event was included in Table E.5-1, but no SAMA was identified. Refer to the response to RAI 5.a for additional information pertaining to the disposition of this event. No additional SAMAs required.
NR-%IE-SACS	1.00E+00	1.018	NONRECOVERY OF %IE-SACS	N	This event was addressed by SAMA 4 Table E.5-1. and SAMA was identified. Refer to the response to RAI 5.a for additional information pertaining to the disposition of this event. No additional SAMAs required.
CAC-AOV-CC-DF01	2.00E-04	1.018	COMMON CAUSE FAILURE OF AIR OPERATED BUTTERFLY VALVES TO OPEN	N	This event is completely tied to event NR-%IE-SACS, which is addressed above.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
1RX-PHE-SUBSUME	1.00E+00	1.017	ACCIDENT TIME DOES NOT EXCEED 4 HRS TO CORE DAMAGE	N	The event was included in Table E.5-2, but no SAMA was identified. 50% of the contributors are Fire Protection or RACS room flooding events that are addressed by SAMAs 7 and 8. An additional 46% are strainer plugging events that are addressed by SAMA 15. No additional SAMAs required.
DCP-EDG-PORTGEN	2.50E-02	1.017	PORTABLE GENERATOR FAILS	Y	
HPI-TDP-FS-OP204	1.39E-02	1.017	HPCI TDP FAILS TO START	N	This event was addressed by SAMA 1 Table E.5-1. No additional SAMAs required.
RHR-XHE-RHR-INJ	1.00E-01	1.016	FAILURE TO ALIGN RHR MOV 17B LOCALLY FOR INJECTION	Y	SAMA 10 was originally proposed to address the scenarios including this failure; however, limited credit may be available for aligning an additional alternate injection system. Almost 70% of the contributors including this event are LOOP scenarios with failure to recover offsite power. SAMA 5 could effectively address these scenarios and the dependence issues between power recovery and injection with Fire Protection would be much less significant.
PCV-XHE-L2-VENT	1.30E-01	1.016	OPERATOR FAILS TO VENT (HC.OP-EO-ZZ.0318)	Y	SAMA 4 was originally proposed to address the scenarios including this failure; however, alternative SAMAs include 7 and 8, which address about 50% of the contribution and SAMA 15, which addressed about 25% of the risk.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
SAC-MDP-TM-SSWA	2.30E-05	1.016	SAC-B IN MAINT. COINCIDENT WITH SSW A	N	The event was included in Table E.5-2, but no SAMA was identified. About 60% of the contributors including this event are conservatively binned to core damage if offsite power is not restored by 20 hours. In these cases, injection is available and local venting can be used for heat removal. If local venting were credited, these scenarios would essentially be eliminated. Many of the scenarios could also be are addressed by SAMA 5 given that the gas turbines do not share the cooling water dependencies with the EDGs. No additional SAMAs required. It should also be noted that this event is not based on plant data or historical events and is not an expected maintenance configuration for the plant. The event has been included in the model to address a supporting requirement of the ASME PRA Standard.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
DGS-DGN-TM-ABCD	2.30E-05	1.015	COINCIDENT MAINTENANCE UNAVAILABILITY OF DG A, DG B, DG C, AND DG D	N	The event was included in Table E.5-2, but no SAMA was identified. About 60% of the contributors including this event are conservatively binned to core damage if offsite power is not restored by 20 hours. In these cases, injection is available and local venting can be used for heat removal. If local venting were credited, these scenarios would essentially be eliminated. Many of the scenarios could also be are addressed by SAMA 5. No additional SAMAs required. It should also be noted that this event is not based on plant data or historical events and is not an expected maintenance configuration for the plant. The event has been included in the model to address a supporting requirement of the ASME PRA Standard.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
%IE-TM	5.62E-02	1.015	MSIV CLOSURE	N	This event was included in Table E.5-1, but no SAMA was identified. About 10 % of the scenarios are scenarios to which the PRA conservatively does not apply local venting credit. An additional 55% of the contribution comes from scenarios in which the plant hardware operates adequately and the operator actions failures are very low. Enhancements that require additional operator action would have very limited benefit due to dependence issues and limitations on operator credit in a single scenario. A passive containment vent is a potential option, but as described in the response to RAI 5.d, it is undesirable from an operations perspective and may provide no net risk reduction. No SAMAs suggested.
HPI-STR-PL-DFLOC	1.00E-04	1.015	CCF PLUGGING OF ECCS SUCTION STRAINERS (LOCA)	N	This event was addressed by SAMA 15 Table E.5-1. It was also included in Table E.5-2, but not connected with a specific SAMA in that table. No additional SAMAs required.
SWS-XHE-RACS-UNI	1.00E+00	1.014	FAILURE TO ISOLATE LOCALLY A SW RUPTURE IN RACS COMPARTMENT	Y	
ESF-XHE-MC-DF01	8.00E-05	1.014	COMMON CAUSE MISCALIBRATION OF ALL ECCS PRESSURE TRANS.	N	The event was included in Table E.5-2, but no SAMA was identified. Providing a manual bypass of the low pressure permissive logic is a means of mitigating these contributors (SAMA 40).

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
XHOS-RIVER-LT70	6.90E-01	1.013	RIVER TEMPERATURE IS LESS THAN 70 F	N	This event was included in Table E.5-1, but no SAMA was identified. Over 40% of the scenarios conservatively do not credit local venting for long heat removal. If this proceduralized action is credited, these cases are no longer significant contributors. About 12% are directly addressed by SAMA 4. An additional 13% are LOOP events addressed by SAMA 5. No additional SAMAs suggested.
%FLFPS-CR	1.10E-05	1.013	FPS RUPTURE OUTSIDE CONTROL ROOM	Y	
FPS-XHE-CRISOL	1.00E+00	1.013	Operator fails to secure FPS given CR area rupture	Y	
MCR-PHE-DOOR	5.00E-01	1.013	MCR DOOR FAILS DUE TO WATER PRESSURE	Y	
RHS-MDP-TM-PB	1.58E-02	1.013	RHS PUMP TRAIN B IN TEST AND MAINT	Y	
LPI-XHE-AT-LVL	4.00E-02	1.013	FAILURE TO CONTROL LP ECCS TO PREVENT OVERFILL	N	The event was included in Table E.5-2, but no SAMA was identified. About 60% of the contributors including this event include failure to bypass the low level MSIV isolation logic. This is addressed the response to RAI 5.j by SAMA RAI5j-IE1. No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
DCP-XHE-PORTA	6.20E-02	1.013	FAILURE TO CROSS TIE BUS TO BATTERY CHARGER PORTABLE SUPPLY	N	This event was addressed by SAMA 5 in Table E.5-1, which could have some impact, but would be limited by dependence issues. Over 40% of the contributors include failure of the SACS HX bypass valves or the temperature controllers that govern the valves. If the PRA model included credit for the existing procedures and training address these failures, they would no longer be significant contributors. An additional 15% of the contribution is addressed by SAMAs 17 and 18 (or in the response to RAI 7.a). No additional SAMAs required.
XHOS-STBY-DP502LT	5.00E-01	1.012	PUMP SSW DP502 IN STANDBY WITH 2 PUMPS OPERATING	N	The event was included in Table E.5-2, but no SAMA was identified. Almost 60% of the scenarios conservatively do not credit local venting for long heat removal. If this proceduralized action is credited, these cases are no longer significant contributors. An additional 20% are related to combinations of power and cooling water failures that could be mitigated by SAMA 4. No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
WW-DW-LK-RUPT	1.00E-01	1.012	RB SYS FAIL DUE TO ENVRON. STRESS WW RUPT/LK	N	This event was addressed by SAMA 5 in Table E.5-2; however, it appears that the intent was to address it with SAMA 4. SAMA 4 is a potential means of mitigating many of the contributors, but almost 50% of the contributors include failure of the SACS HX bypass valves or the temperature controllers that govern the valves. If the PRA model included credit for the existing procedures and training address these failures, they would no longer be significant contributors. An additional 20% of the contributors are related to remote vent valve failures. Credit is conservatively not taken for local vent action to bypass these failures, but if credit is applied, these failures are no longer significant contributors. No additional SAMAs required.
IE-LOOP-CND-L	2.40E-02	1.011	CONDITIONAL LOOP GIVEN TRANSIENT WITH LOCA SIGNAL	Y	

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
%IE-TF	4.49E-02	1.011	LOSS OF FEEDWATER	N	The event was included in Table E.5-2, but no SAMA was identified. Most of the contribution comes from loss of CHR scenarios in which the plant hardware operates adequately and the HEPs are very low. For the ATWS level control failures, the HEPs are not as low, but the operators are well trained and SLC functions properly. For loss of CHR, enhancements that require additional operator action would have very limited benefit due to dependence issues and limitations on operator credit in a single scenario. A passive containment vent is a potential option, but as described in the response to RAI 5.d, it is undesirable from an operations perspective and may provide no net risk reduction. About 11% of the contributors can be mitigated by an uncredited local venting action. No additional SAMAs suggested.
%IE-SORV2	2.44E-04	1.011	2 or More SORVs	Y	
IAS-MDC-FR-K100	6.09E-02	1.011	EIA COMPRESSOR FAILS TO RUN	Y	

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
NR-ATWS-ADS-INH	1.50E-02	1.011	FAILURE TO INHIBIT ADS DURING AN ATWS (W/O FW)	N	The event was included in Table E.5-2, but no SAMA was identified. About 55% of the contributors include failure to bypass the low level MSIV isolation logic. This SAMA is identified and evaluated in the response to RAI 5.j (SAMA RAI5j-IE1). The remaining contributors include failure to inhibit ADS, which is a well trained action. Given the availability of auto-SLC, no further enhancements had been identified to address these ATWS events.
HPI-TDP-TM-OP204	1.09E-02	1.01	HPI TURBINE TRAIN OP204 IN TEST AND MAINT	Y	
CGS-PHE-SC-INERT	1.00E-02	1.01	CONTAINMENT NOT INERTED; VENTING REQUIRED	Y	SAMAs 7 and 15 are also applicable.
DGS-DGN-FS-BG400	1.31E-02	1.01	DIVISION B DIESEL 1BG400 FAILS TO START	Y	
1CZPH-EXVSLSTF--	1.00E-02	1.01	EX-VESSEL STEAM EXPLOSION	Y	SAMAs 7 and 15 are also applicable.
FPS-XHE-ALIGN	5.80E-02	1.009	FAILURE TO ALIGN FPS FOR INJECTION IN TIME	N	The event was included in Table E.5-2, but no SAMA was identified. About 45% of the contributors including this event are related to failure of the SACS Hx Bypass valves or the temperature controller for the valves (leads to SBO in a LOOP). If credit is taken for existing procedures and training, these contributors would effectively be eliminated. The remaining contributors are addressed by SAMA 5. No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
LPI-XHE-AT-LVLF	1.00E-01	1.009	FAILURE TO CNTRL LP ECCS TO PRVNT OVERFILL GIVEN HPI FAILS	N	The event was included in Table E.5-2, but no SAMA was identified. Over 60% of the contributors include failure to bypass the low level MSIV isolation logic. This SAMA is identified and evaluated in the response to RAI 5.j (SAMA RAI5j-IE1). The remaining contributors include early level control failure, which is a well trained action. Given the availability of auto-SLC, no further enhancements had been identified to address these ATWS events.
NRHVCSWGR24-01	4.10E-03	1.009	Fail to restore SWGR room cooling	Y	
SLC-TNK-LO-10204	7.55E-03	1.008	SLC STORAGE TANK CONCENTRATION OUT OF SPEC.	N	The event was included in Table E.5-2, but no SAMA was identified. An independent liquid boron injection system that is tested and maintained separately could be installed to address these types of failures (SAMA RAI5p-1).
%FLTORUS	2.80E-06	1.008	TORUS RUPTURE IN TORUS ROOM	N	The event was included in Table E.5-2 and SAMA 1 was identified as a potentially relevant enhancement; however, SAMA 1 would have only a small impact on these contributors. Refer to the response to RAI 5.a for a disposition of this event.
DGS-DGN-FS-AG400	1.31E-02	1.008	DIVISION A DIESEL 1AG400 FAILS TO START	Y	
OSPR30MIN-GR	8.25E-01	1.008	FAILURE TO RECOVER GRID LOOP W/IN 30 MIN.	Y	
RCI-MOV-LK-ROOM	1.00E-01	1.008	PROBABILITY OF STEAM LEAK INTO RCI ROOM		

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
SWS-STR-FR-DF01	2.78E-06	1.007	CCF FAILURE TO RUN ALL SWS STRNR MOTORS	Y	The event was included in Table E.5-2 and addressed with SAMA 5, which could provide some benefit. However, 63% of the contribution is related to remote failures of valves HV-4964 or HV-11541. The PRA model conservatively does not credit the local venting action to bypass these failures, but the action is applicable. An additional 15% of the contributors conservatively do not credit local containment vent in long term SBO scenarios with portable generator and diesel fire injection success, but again, local venting is applicable. No additional SAMAs required.
HPI-XHE-AT-CS	1.10E-01	1.007	CREW BLOWS DOWN BEFORE LVL IS CONTROLLED BY HPCI (3600 GPM)	N	The event was included in Table E.5-2, but no SAMA was identified. About 60% of the contributors include failure to bypass the low level MSIV isolation logic. This SAMA is identified and evaluated in the response to RAI 5.j (SAMA RAI5j-IE1). No additional SAMAs required.
DGS-DGN-FS-DG400	1.31E-02	1.007	DIVISION D DIESEL 1DG400 FAILS TO START	Y	

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
LOOP-IE-SWYD	4.03E-01	1.007	COND. PROBABILITY LOOP DUE TO SWYD EVENT	Y	This event was addressed by SAMA 5 in Table E.5-2. However, over 60% of the contributors include failure of the SACS HX bypass valves or the temperature controllers that govern the valves. If the PRA model included credit for the existing procedures and training address these failures, they would no longer be significant contributors. An additional 15% of the contributors are related to remote vent valve failures. Credit is conservatively not taken for local vent action to bypass these failures, but if credit is applied, these failures are no longer significant contributors. No additional SAMAs required.
DIA-NOT	2.20E-02	1.007	DRYWELL INTACT (CLASS IIA)	N	The event was included in Table E.5-2, but no SAMA was identified. However, over 60% of the contribution is related to remote failures of valves HV-4964 or HV-11541. The PRA model conservatively does not credit the local venting action to bypass these failures, but the action is applicable. An additional 3.5% of the contribution is related to SACC Hx Bypass valve failures that do not include credit for the local recovery actions governed by existing plant procedures. No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
WWA	1.00E+00	1.007	WETWELL AIRSPACE FAILURES (CLASS IIA)	N	The event was included in Table E.5-2 and addressed by SAMA 4. SAMA 4 may provide some benefit; however, over 60% of the contribution is related to remote failures of valves HV-4964 or HV-11541. The PRA model conservatively does not credit the local venting action to bypass these failures, but the action is applicable. An additional 3.5% of the contribution is related to SACC Hx Bypass valve failures that do not include credit for the local recovery actions governed by existing plant procedures. No additional SAMAs required.
SAC-MDP-TM-SSWB	2.30E-05	1.006	SAC A IN MAINT. COINCIDENT WITH SSW B	N	The event was included in Table E.5-2, but it is addressed with SAMA 3, which does not mitigate the high-moderate contributors. About 65% of the contributors containing the event are binned to core damage without crediting local containment venting. If this action is credited, these scenarios are no longer important contributors. Given that the gas turbine does not share the SACS cooling water dependencies with the EDG, SAMA 5 would address many of the remaining scenarios. No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
NR-UV-WTLVL-20M	2.10E-02	1.006	FAILURE TO CONTROL RPV WATER LVL W/HIGH PRESS. INJ. SYS.	Y	The event was included in Table E.5-2, but it is addressed with SAMA 1 via Table E.5-1. Given that 100% of the contributors include portable generator hardware failure, it is assumed that SAMA 5 was intended to address this event. No additional SAMAs required.
%IE-MLRHR	1.44E-05	1.006	Medium LOCA – RHR	N	Over 75% of the contributors include failure to manually depressurize the RPV. SAMA 1 is applicable.
DGS-DGN-FS-DF01	1.03E-05	1.006	CCF FAILURE TO START OF SDG'S A -B -C - AND D	N	Over 65% of the contributors containing this event are binned to core damage without crediting local containment venting. If this action is credited, these scenarios are no longer important contributors. An additional 15% include successful operator alignment of the portable generator with generator hardware failure or injection alignment failures, which could be addressed by SAMA 5. No additional SAMAs required.
CAC-AOV-VF-11541	1.20E-04	1.006	HV-11541 FAILS DUE TO HARSH ENVIRONMENT	N	About 30% of the contributors include Service Water Pump Room cooling failures. These can be addressed by SAMAs 17 and 18. Also, proceduralizing the use of alternate room cooling is a potential solution (refer to the response to RAI 7.a for additional information).

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
CAC-AOV-VF-4964	1.20E-04	1.006	HV-4964 FAILS DUE TO HARSH ENVIRONMENT	N	About 30% of the contributors include Service Water Pump Room cooling failures. These can be addressed by SAMAs 17 and 18. Also, proceduralizing the use of alternate room cooling is a potential solution (refer to the response to RAI 7.a for additional information).
%FLSWAB-RACS-U	7.60E-08	1.006	FREQ OF COMMON HEADER TO RACS RUPTURE (UNISOLABLE)	N	The event was included in Table E.5-2, but no SAMA was identified. These flooding scenarios can be addressed by SAMA 7. No additional SAMAs required.
DGS-DGN-TM-BG400	1.30E-02	1.006	DGS TRAIN BG400 IN TEST AND MAINT	Y	
NR-SOX-DEP-SRV	1.60E-03	1.005	FAILURE TO MAN. DEPRESS. FOR AN SORV W/NO HIGH PRESS. INJ.	N	The scenarios including this failure can be mitigated by SAMA 1.
TAF-S	9.13E-01	1.005	BREAK ABOVE TAF (BOC)	N	About 50% of the contribution includes breaks in the steam tunnel. For these breaks, the reactor building is not significantly degraded and the ECCS systems are potentially available, but have otherwise failed. Alternate injection is a viable means of preventing core damage, but the PRA conservatively does not credit service water injection through RHR. If SW injection were credited, these scenarios would no longer be significant contributors. No additional SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
SRV-TNK-LK-TRANS	1.00E-04	1.005	FAILURE OF 13/14 ACCUMULATORS (LEAKAGE) (NON-SBO)	N	The event was included in Tables E.5-1 and E.5-2, but no SAMA was identified. Almost all of the contributing scenarios include HPCI/RCIC success. Credit is conservatively no taken for the gradual cooldown that would occur and the ability to transition to RHR for level control and heat removal. If this control transition was credited, these contributors would be eliminated. No additional SAMAs required.
CAC-DSK-RUPTURE	1.00E-04	1.005	RUPTURE DISK FAILS TO RUPTURE	N	About 30% of the contributors include Service Water Pump Room cooling failures. These can be addressed by SAMAs 17 and 18. Also, proceduralizing the use of alternate room cooling is a potential solution (refer to the response to RAI 7.a for additional information).
CNT-SPE-LV-GT180	1.00E-04	1.005	TORUS WATER LEVEL GT 180 IN.	N	High water level in the Torus prevents torus venting while loss of SW fails air to the 6" hard pipe vent for heat removal (65% of the contributors). These scenarios could be addressed by SAMA 3, but steps would likely be taken to address torus water level if the torus vent was needed. No SAMAs required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
CAC-VFC-AF-11541	1.00E-02	1.005	HV-11541 ACTUATOR ON 102' FAILS	N	About 30% of the contributors include Service Water Pump Room cooling failures. These can be addressed by SAMAs 17 and 18. Also, proceduralizing the use of alternate room cooling is a potential solution (refer to the response to RAI 7.a for additional information).
CAC-VFC-AF-4964	1.00E-02	1.005	HV-4964 ACTUATOR ON 102' FAILS	N	About 30% of the contributors include Service Water Pump Room cooling failures. These can be addressed by SAMAs 17 and 18. Also, proceduralizing the use of alternate room cooling is a potential solution (refer to the response to RAI 7.a for additional information).
ADS-XHE-FW-INH	6.00E-03	1.005	FAILURE TO INHIBIT ADS DURING AN ATWS WITH FW OR HPCI	N	Failing to inhibit ADS results in the uncontrolled depressurization of the RPV and addition of cold water and core damage when the low pressure permissive is satisfied for ATWS scenarios. It is technically possible to disable ADS such that automatic depressurization would not occur for ATWS, but based on the high importance of manual depressurization failure, this would result in a net risk increase even though it may eliminate the "failure to inhibit" scenarios. No SAMAs are suggested.
%IE-MLRECIRC	1.18E-05	1.005	Medium LOCA – Reactor Recirculation	N	About 75% of these LOCA scenarios include failure of manual depressurization, which are addressed by SAMA 1.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
DCP-BDC-ST-DF01	3.87E-08	1.005	CCF FAILURE 125VDC BUSES 10D410 - 20 - 30 - & 40	N	The event was included in Table E.5-2, but no SAMA was identified. HCGS has procedures to operate RCIC without AC or DC power that are not credited. While failure of the DC panels in the earliest time frames of an accident may preclude full implementation of the procedure, it is expected that many of the scenarios could be mitigated with local RCIC operation. No additional SAMAs required.
CRH-SPE-ARI-FAIL	5.00E-02	1.005	FAILURE OF THE AUTO ARI	N	About 30% of the contributors include failure to bypass the low level MSIV isolation logic. This SAMA is identified and evaluated in the response to RAI 5.j (SAMA RAI5j-IE1). About 50% of the contribution is related to failure to control level early. Given the availability of auto-SLC and that the operators are well trained on ATWS scenarios, no further enhancements had been identified to address these ATWS events.
RPPARPS-ELECFCC	3.70E-06	1.005	RPS ELECTRICAL FAILURE	N	About 30% of the contributors include failure to bypass the low level MSIV isolation logic. This SAMA is identified and evaluated in the response to RAI 5.j (SAMA RAI5j-IE1). About 50% of the contribution is related to failure to control level early. Given the availability of auto-SLC and that the operators are well trained on ATWS scenarios, no further enhancements had been identified to address these ATWS events.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
VSW-FAN-FR-DF12	9.90E-06	1.005	CCF FAILURE FANS A THRU DVH401 FAIL TO RUN	Y	
CSS-STR-PL-A	8.36E-03	1.005	CSS PUMP A SUCTION STRAINERS PLUGGED IN STANDBY	Y	
CSS-STR-PL-B	8.36E-03	1.005	CSS PUMP B SUCTION STRAINERS PLUGGED IN STANDBY	Y	
CSS-STR-PL-C	8.36E-03	1.005	CSS PUMP C SUCTION STRAINERS PLUGGED IN STANDBY	Y	
CSS-STR-PL-D	8.36E-03	1.005	CSS PUMP D SUCTION STRAINERS PLUGGED IN STANDBY	Y	
IGS-XHE-FO-V5125	1.20E-01	1.005	OPERATOR FAILS TO OPEN XCONNECT VALVE	N	Almost all of the contributing scenarios include HPCI/RCIC success. Credit is conservatively no taken for the gradual cooldown that would occur and the ability to transition to RHR for level control and heat removal. If this control transition was credited, these contributors would be eliminated. No additional SAMAs required.
ACP-BAC-HV-RMCLG	9.00E-01	1.005	FAILURE OF EQUIPMENT GIVEN NO SWG ROOM COOLING	Y	
OP1-IA-NOT	8.40E-01	1.005	RPV DEPRESSURIZATION SUCCESSFUL (IA)	N	The event was included in Table E.5-2, but no SAMA was identified. About 20% of the contributors are floods initiated in the fire protection system which can be addressed with SAMA 8. Over 70% of the contributors include loss of all DC power. HCGS has procedures to operate RCIC without AC or DC power, but they are not credited. No additional SAMAs are required.

Table 5.p-1
DISPOSITION OF RISK DOMINANT LEVEL 2 CONTRIBUTORS

Event Name	Probability	Risk Reduction Worth	Description	Addressed in ER Table E.5-2?	Comments or Potential SAMAs
IGS-LOCASIG	1.00E+00	1.005	LOCA SIGNAL PRESENT WHEN PCIGS NEEDED	N	Almost all of the contributing scenarios include HPCI/RCIC success. Credit is conservatively no taken for the gradual cooldown that would occur and the ability to transition to RHR for level control and heat removal. If this control transition was credited, these contributors would be eliminated. No additional SAMAs required.

Table 5.p-2
RESULTS BY RELEASE CATEGORY

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	Total
$Frequency_{BASE}$	1.83E-07	7.15E-08	1.30E-07	9.70E-07	8.34E-08	3.48E-07	2.16E-07	0.00E+00	2.68E-07	2.39E-07	1.93E-06	**4.44E-06**
$Frequency_{SAMA}$	1.68E-07	7.15E-08	1.30E-07	9.70E-07	8.34E-08	3.35E-07	2.16E-07	0.00E+00	2.68E-07	2.39E-07	1.93E-06	**4.41E-06**
$Dose\text{-}Risk_{BASE}$	3.33	0.99	3.05	8.49	0.92	4.55	1.37	0.00	0.00	0.16	0.00	**22.86**
$Dose\text{-}Risk_{SAMA}$	3.06	0.99	3.04	8.49	0.92	4.39	1.37	0.00	0.00	0.16	0.00	**22.42**
$OECR_{BASE}$	$21,045	$6,888	$14,975	$62,159	$7,694	$31,881	$10,235	$0	$0	$177	$0	**$155,055**
$OECR_{SAMA}$	$19,320	$6,885	$14,950	$62,177	$7,698	$30,720	$10,217	$0	$0	$177	$0	**$152,144**

5.q Section E.5.1.3.7 identifies SAMA 11 as having been identified from the review of selected industry analyses. However this SAMA is not included in the list of Phase 1 SAMAs (Table E.5-3) and it was not evaluated in the environmental report (ER). Furthermore, the disposition of James A. Fitzpatrick Nuclear Power Plant SAMA 62 in Section E.5.1.3.3 states that a SAMA to develop a procedure to open the door of [emergency diesel generator (EDG)] buildings upon high temperature alarm (i.e., HCGS SAMA 11) was not included due to the small contribution to HCGS risk. Clarify this discrepancy and provide an evaluation of SAMA 11, if applicable.

PSEG Response:

EDG room cooling is not a significant contributor to the HCGS risk profile, as identified in the disposition of James A. Fitzpatrick Nuclear Power Plant SAMA 62 in Section E.5.1.3.3 of the HCGS ER.

For HCGS, each EDG is supported by redundant room cooling trains; scenarios including fan or flow-path failures of both trains fall below the truncation limits for the Level 1 and Level 2 PRA models. Further, the Safety Auxiliaries Cooling System (SACS) supports EDG Building room cooling and EDG jacket water cooling. Consequently, a loss of SACS cannot be mitigated by opening the EDG Building doors because the EDGs would still fail due to lack of jacket water cooling. For these reasons, a procedure change to direct the operators to open the EDG Building doors on loss of room cooling is not required for HCGS.

HCGS SAMA "I1" (Industry 1) should not be included in summary section E.5.1.3.7 of the ER. Section E.5.1.3 was developed in stages, including one that implemented a preliminary SAMA numbering format. While the preliminary draft of Section E.5.1.3.7 originally identified SAMA I1 as a potential SAMA for inclusion on the HCGS list, it was ruled out after a review of the HCGS configuration and PRA results.

5.r PSEG's review of the Duane Arnold Energy Center (Duane Arnold) SAMAs in Section E.5.1.3.5 did not address Duane Arnold SAMA 117, "increase boron concentration or enrichment in the standby liquid control SLC system," which was determined to be potentially cost-beneficial in the uncertainty analysis. Review this SAMA for applicability to HCGS and provide an evaluation of this SAMA, if applicable.

PSEG Response:

Increasing the boron concentration of the SLC system, as proposed in DAEC SAMA 117, is intended to increase the length of time that is available for the operator to initiate SLC injection in an ATWS scenario. The SLC system at HCGS is automatically initiated and the proposed SAMA would have a negligible benefit for the plant. Scenarios including the manual SLC initiation action fall below the truncation limit for both the Level 1 and Level 2 HCGS PRA models.

6. Provide the following with regard to the Phase 2 cost-benefit evaluations:

6.a Section E.6 states that plant personnel developed HCGS-specific implementation cost estimates for each of the SAMAs. Provide a description of: the process PSEG used to develop the SAMA implementation costs, the level of detail used to develop the cost estimates (e.g., general cost categories such as hardware design, procurement, installation, and testing, procedure development, quality assurance and licensing support, etc.), and how the calculations are documented. Specifically discuss whether the cost estimates include replacement power costs during outages required to implement the modifications, contingency costs for unforeseen difficulties, and inflation.

PSEG Response:

Following initial development of the SAMAs, a series of meetings were held between the personnel responsible for the SAMA development and the two PSEG License Renewal Site Leads. The Site Leads are Engineering Managers and each have over 25 years of plant experience including over 10 years with PSEG Nuclear. This experience includes project management, operations, plant engineering, design engineering, procedure support, simulators, and training. The purpose of the meetings was to validate each SAMA against plant configuration and to develop an estimate of its implementation cost. In some instances, the Site Leads provided information that was used to refine the SAMA or to develop an alternate approach to reach the same objective at a lower implementation cost. At the conclusion of the series of meetings, the SAMAs were provided to the Design Engineering Manager for review and comment from both technical and cost perspectives. The SAMA information in the LRA reflects the final product of this process.

As shown in the following table, there are seven general cost categories. Costs are budgetary estimates, not detailed estimates. The cost estimates do not include contingencies or inflation. In addition to the cost information, the table provides a summary of the SAMA changes. This table was prepared for each SAMA during the previously described series of meetings.

SAMA 5: Improve Procedural Guidance for Restoration of AC Power Using Gas Turbine	
Engineering	$700,000
Material	$700,000
Installation	$600,000
Licensing	$0
Critical Path Impact	$0
Simulator Modification	$20,000
Procedures and Training	$30,000
Total Cost	$2,050,000
Summary:	
This SAMA would allow for improved usage of Salem 3 (gas turbine generator) to provide power to the Hope Creek emergency buses. It assumes that Salem SAMA 2 has been implemented since this SAMA disconnects Salem 3 from its current switchyard interfaces and connects it to a dedicated transformer to provide power to Salem 1 and 2. This Hope Creek SAMA provides the necessary equipment to connect this dedicated transformer to Hope Creek. It is a safety-related permanent plant modification.	

Safety-related modifications are significantly more expensive than other types of modifications. Permanent modifications are more expensive than temporary actions such as staging fans for usage during loss of HVAC.

If a SAMA requires an outage for implementation, it is assumed that implementation occurs during a refueling outage. The general category of "Critical Path Impact" is used only when the associated changes would extend the Critical Path. For example, if a typical refueling outage would be extended 12 hours due to the associated changes, the SAMA cost would include 12 hours of lost generation.

With respect to the general category of "Procedures and Training", the cost estimate considers the complexity of the SAMA. Some plant modifications, such as creating new procedures to operate the plant with a loss of all 1E 120VAC power, involve revisions to a large number of procedures, affect multiple groups (ex. Operations and I&C), and require significant training (ex. simulator, classroom, and field). Accordingly, the cost estimates are higher than a relatively simple procedure change such as one allowing an existing, non-Technical Specification procedure to be used under additional circumstances. A simple procedure change has a typical cost of $50K.

6.b The cost estimate for SAMA 5 ($2.05M) seems high for what is stated to be procedure changes and operator training. Provide justification for the cost estimate.

PSEG Response:

A table was prepared for each SAMA that included cost estimates and a summary of the SAMA changes. This table is provided for Hope Creek SAMA 5. Hope Creek SAMA 5 assumes that Salem SAMA 2 has been implemented since this SAMA disconnects Salem 3 from its current switchyard interfaces and connects it to a dedicated transformer to provide power to Salem 1 and 2 (not to Hope Creek). Hope Creek SAMA 5 provides the necessary equipment to connect this dedicated transformer to Hope Creek. As shown in the table, most of the cost is in the categories of Engineering, Material, and Installation ($2M). Only $30K is associated with the category of Procedures and Training. The cost estimate is justified.

SAMA 5: Improve Procedural Guidance for Restoration of AC Power Using Gas Turbine	
Engineering	$700,000
Material	$700,000
Installation	$600,000
Licensing	$0
Critical Path Impact	$0
Simulator Modification	$20,000
Procedures and Training	$30,000
Total Cost	$2,050,000
Summary:	
This SAMA would allow for improved usage of Salem 3 (gas turbine generator) to provide power to the Hope Creek emergency buses. It assumes that Salem SAMA 2 has been implemented since this SAMA disconnects Salem 3 from its current switchyard interfaces and connects it to a dedicated transformer to provide power to Salem 1 and 2 (not to Hope Creek). This Hope Creek SAMA provides the necessary equipment to connect this dedicated transformer to Hope Creek. It is a safety-related permanent plant modification.	

6.c In Section E.6.4, the benefit of utilizing the gas-turbine generator (SAMA 5) was assessed by reducing the probability of failure to cross-tie the HCGS EDGS. This assumption does not provide credit for the gas turbine in the situation where all the emergency generators are unavailable. Discuss the impact of this omission.

PSEG Response:

Per Section E.6.4, reducing the operator action for cross tie of the EDGs from 0.99 to 0.1 reduces the Level 1 CDF from 4.44E-6/yr to 4.10E-6/yr (i.e., a 7.7% decrease). It is understood that modeling cross tie of the HCGS EDGs as a surrogate for utilizing the Salem gas turbine generator (GTG) to supply HCGS does not credit the GTG in situations where all of the EDGs are unavailable. However, using the EDG cross tie as a surrogate overestimates the benefit of the GTG for the following reasons:

- Cross tie of the EDGs is credited for all types of LOOP scenarios (i.e., plant centered, switchyard related, grid related, and weather related). In addition, for the purposes of SAMA 5, the EDG crosstie is assumed to be aligned and credited at time=0.
- In the HC108B PRA, the GTG is only credited under certain types of LOOP scenarios. For example, the GTG is only credited for the portion of LOOP events that are grid related. The GTG is not credited for weather related LOOP events because the weather is assumed to preclude the ability to successfully perform cross tie operator actions in the switchyard. The GTG is also not credited for plant centered and switchyard related LOOP events because the GTG needs to be aligned through the HCGS switchyard to the HCGS AC distribution system.
- Based on the HCGS Human Reliability Analysis (HRA), the GTG can be aligned within approximately 2 hours. Therefore, the GTG is not credited for LOOP scenarios with core damage in less than 2 hours. In the HC108B PRA, the GTG is only credited for LOOP scenarios where core damage is greater than 4 hours (i.e., non-LERF scenarios).

A sensitivity study was performed using the HC108B model to assume that the GTG was always available and reliable (i.e., failure probability, maintenance unavailability, and human error probability set to 0.0). Given the constraints for crediting the GTG as identified above, the sensitivity study showed that the Level 1 CDF decreased from 4.44E-6/yr to 4.41E-6/yr (i.e., <1% decrease).

Using the EDG crosstie as a surrogate evaluation for the GTG would overestimate the benefit of the GTG. Not crediting the GTG in situations where all of the EDGs are unavailable does not change the conclusions of SAMA 5.

6.d The implementation cost for SAMA 10 ($100K) was based on the estimated cost of a procedure change. However, the plant modification for SAMA 10 is described as including the addition of a new pump. Provide justification for the cost estimate.

PSEG Response:

The particular wording used in Section E.6.7 of the SAMA report, "adding a new pump," was misinterpreted as the purchase of a pump that does not currently exist. However, use of the existing B.5.b security pump, which is included in the title description for this SAMA, should be interpreted as making an existing pump available for use that was not previously credited by procedures such that the ability to use a pump not previously available to the operator was considered a "new" pump. Therefore, the cost of this SAMA is based on upon procedure revisions and operator training; purchase of new hardware or equipment was not considered necessary.

6.e SAMA 16, which involves replacing one of the four Switchgear Room cooling fans with a fan having a different design, was estimated to cost $400K. Provide justification for the cost estimate. In addition, the description of this SAMA notes that an alternate means of cooling could involve use of multiple portable fans. Clarify whether this is a potentially lower cost alternative to SAMA 16 and, if so, provide an evaluation of a SAMA using multiple portable fans.

PSEG Response:

A table was prepared for each SAMA that included cost estimates and a summary of the SAMA changes. The following table provides the cost breakdown for SAMA 16.

SAMA 16: Use of Different Designs for Switchgear Room Cooling Fans	
Engineering	$150,000
Material	$100,000
Installation	$100,000
Licensing	$0
Critical Path Impact	$0
Simulator Modification	$0
Procedures and Training	$50,000
Total Cost	$400,000
Summary:	
This SAMA considers replacing one of the switchgear room cooling fans with a different design so as to eliminate common cause failure of all fans.	

The use of portable fans and recovery of switchgear room cooling is already credited within the PRA model via the HEP event NRHVCSWGR24-01. This event appears in Table E.5-1 of the ER and was considered to be addressed by SAMA 16. That is, the failure of operators to stage portable fans is already identified in those same cutsets that involve common-cause failure of all switchgear room cooling fans. Hence, the installation of a fan of a different design was considered as one means of avoiding common-cause failure of all fans.

6.f SAMA 31 is similar to Salem SAMAs 21and 22 in that each involves installing fire barriers to prevent the propagation of a fire between cabinets. HCGS SAMA 31 has an estimated cost of $1.2M (one cabinet) compared to $3.23M (48 cabinets) and $1.6M (three cabinets) for Salem SAMAs 21 and 22, respectively. Clarify why the cost of installing fire barriers in one cabinet (HCGS SAMA 31) is only 25 percent less than the cost for three cabinets (Salem SAMA 22) and only half the cost of 48 cabinets (Salem SAMA 21).

PSEG Response:

A table was prepared for each SAMA that included cost estimates and a summary of the SAMA changes. This table is provided for Hope Creek SAMA 31. Although Salem SAMA 21 involves more cabinets, it is significantly simpler than Salem SAMA 22 due to the location and structure of the cabinets in the Relay Room. Similar to Salem SAMA 22, Hope Creek SAMA 31 is more complicated than Salem SAMA 21 because it involves the Control Room consoles. Engineering costs are the same for Hope Creek SAMA 31 and Salem SAMA 22 ($800K). The material and installation costs per console are also the same ($200K). The difference in total cost is due to the fact that the Engineering cost at Salem is shared between two units and that there are three affected consoles in each Salem unit and only one affected console at Hope Creek. The differences in the cost estimates are justified.

SAMA 31: Improve Fire Barrier Protecting Control Console with MSIV Controls	
Engineering	$800,000
Material	$200,000
Installation	$200,000
Licensing	$0
Critical Path Impact	$0
Simulator Modification	$0
Procedures and Training	$0
Total Cost	$1,200,000
Summary:	
This SAMA involves improving the capability of the MSIV console in the Control Room to contain a fire (i.e. fire barrier) and thus stop propagation of the fire to adjacent consoles. This console has tight internal clearances and many openings for instrumentation. In addition to adding fire barrier materials, the console has significant heat loads so ventilation modifications will be needed. The Engineering costs include $100K for a feasibility study. This SAMA involves permanent plant modifications.	

6.g In Section E.6.17, it is stated that SAMA 35 was conservatively assumed to eliminate 99 percent of the risk associated with basic event %IE-FIRE38. However, the estimated total averted cost-risk is calculated using a reduction of only 90 percent. Clarify this discrepancy.

PSEG Response:

The method used to calculate the averted cost-risk of SAMA 35 in the ER was tied to changes in the HCGS CDF rather than through a direct calculation using the fire scenario potential averted cost-risk values (PACR). A more accurate method of calculating the averted cost-risk is to multiply the %IE-FIRE38 PACR by 0.99 to obtain the averted cost-risk. Based on the PACRs provided in the ER, this would be $410,746:

Averted Cost-Risk = $414,895 * 0.99 = $410,746

If the averted cost-risk is recalculated using the fire PACRs from the response to RAI 5.j, the result is similar:

Averted Cost-Risk = $412,626 * 0.99 = $408,500

The conclusion that SAMA 35 is cost beneficial is not impacted as both of the above averted cost-risk values are larger than the $370,000 estimate that was used in the ER.

6.h The cost estimate for SAMA 36 ($270K) seems high for what appears to be a procedure change. Provide justification for the cost estimate.

PSEG Response:

A table was prepared for each SAMA that included cost estimates and a summary of the SAMA changes. This table is provided for SAMA 36. This SAMA involves the creation of a group of procedures; not the revision of existing procedures or creation of a single procedure. Currently, procedures identify the major equipment that is impacted on the loss of individual buses but there is no integrated procedural guidance for loss of all buses. It would be a significant effort to determine a success path, to update the Simulator to include all necessary components to implement the success path, to test the success path, and then to implement the new procedures. It is possible that the preferred success path could involve permanent plant modifications. For the current estimate, it is assumed that there are no permanent plant modifications. The cost estimate is justified.

SAMA 36: Provide Procedural Guidance for Loss of All 1E 120VAC Power	
Engineering	$0
Material	$0
Installation	$0
Licensing	$0
Critical Path Impact	$0
Simulator Modification	$70,000
Procedures and Training	$200,000
Total Cost	$270,000
Summary:	
This SAMA involves the development of procedures to operate the plant after a loss of all class 1E 120VAC power. It involves the creation of a group of procedures; not the revision of existing procedures or creation of a single procedure. Currently, procedures identify the major equipment that is impacted on the loss of individual buses but there is no integrated procedural guidance for loss of all buses. It would be a significant effort to determine a success path, to update the Simulator to include all necessary components to implement the success path, to test the success path, and then to implement the new procedures. It is possible that the preferred success path could involve permanent plant modifications. For the current estimate, it is assumed that there are no permanent plant modifications.	

6.i Provide the assumptions and PRA modeling changes used to model SAMAs 39 and 40 in Sections E.6.20 and E.6.21.

PSEG Response:

SAMA 39: Defeat HPCI/RCIC Torus Back Pressure Trip

During certain postulated plant scenarios where HPCI or RCIC are the only means of RPV injection and the main condenser and Torus Cooling are unavailable. Loss of suppression pool cooling would eventually lead to loss of HPCI/RCIC due to a turbine back pressure trip (e.g., RCIC @ 25 psig, HPCI @ 140 psig, or pool temperature above HCTL). For these types of scenarios, it desirable to defeat the trip to allow continued HPCI/RCIC injection into the RPV.

This SAMA involves adding an operator action to defeat the HPCI/RCIC back pressure trip. This involves changing procedures and providing a means for defeating the trip (e.g., jumpers or keylocks).

Assumptions:

1. For the purposes of this SAMA, it is assumed that the procedures and training would change to allow use of this defeat.
2. The HPCI turbine back pressure trip is currently 140 psig. Bypass of the HPCI back pressure trip would not be required for any PRA modeled scenarios. This SAMA should only apply to bypass of the RCIC turbine back pressure trip.
3. HPCI and RCIC with suction from the Torus can run for 24 hours without Torus Cooling. The containment conditions would likely reach the HCTL within 24 hours, require RPV depressurization, and preclude continued HPCI and RCIC operation. For the purposes of this SAMA, HPCI and RCIC are assumed to continue operating for 24 hours.
4. This SAMA is credited for transient scenarios with loss of the main condenser, loss of Torus Cooling, loss of CRD, and failure to depressurize the RPV. This SAMA is not credited for LOCA scenarios because the RPV would eventually depressurize and preclude HPCI/RCIC operation. This SAMA is not credited for SBO scenarios because HPCI/RCIC operation would be limited by DC battery life.
5. A human error probability (HEP) of 1E-1 was selected as a screening value to model this SAMA.

PRA Model Changes to Model SAMA 39:

The operator action to defeat the HPCI/RCIC back pressure permissive (HPI-XHE-FO-DFT-BP =1.0E-2) was added under the AND gate GTR-026_F. This gate models the following scenario for the loss of RPV makeup at high RPV pressure:

- General Transient Initiating Events
- Feedwater or Power Conversion Systems Fail
- RHR In SPC Mode Fails Early
- HPCI or RCIC are initially available for high pressure injection, but are assumed unavailable long term (e.g., to support the 24 hour mission time) due to reaching the HCTL or the HPCI/RCIC turbine back pressure trip
- Enhanced CRD Unavailable
- Rx Depress Fails When Needed (Gen Trans)

The model was requantified with this change. The change to this specific accident sequence represents the full impact of the addition of this recovery action. No other basic events or fault tree structures were affected.

As identified in Section E.6.20 of the HCGS Environmental Report, the model change resulted in decreasing the CDF from the base value of 4.44E-6/yr to 4.01E-6/yr (i.e., a decrease of 9.8%).

SAMA 40: Defeat RPV Low Pressure Permissive

This SAMA increases the reliability of the low pressure ECCS RPV low pressure permissive circuitry. Given hardware failure or miscalibration of the low pressure permissive circuitry, this SAMA evaluates the benefit of installing a manual bypass of the low pressure permissive logic.

The ability of LPCI/CS to inject requires that the RPV be at low pressure. The Low Pressure Permissive instrumentation is utilized to sense the pressure at which these low pressure systems may inject into the RPV. The malfunction of this instrumentation could prevent injection even when RPV pressure is at the allowed set point. The PRA includes the possibility of the common cause miscalibration of multiple low RPV pressure instruments (ESF-XHE-MC-DF01).

This SAMA involves installing a manual bypass of the low pressure permissive logic. This will allow low pressure systems to inject when the failure is due to a false pressure instrumentation or logic (ESF-XHE-MC-DF01). This change requires procedure and operator training to realize the benefit of this SAMA.

<u>Assumptions:</u>

1. For the purposes of this SAMA, it was assumed that this system would require manual operation from the control room.
2. Failure of the both LPCI and CSS is due to common cause failure or miscalibration of the RPV Low Pressure Permissive instrumentation.

3. A HRA failure probability of 1E-1 was selected as a screening value

PRA Model Changes to Model SAMA 40:

The probability for representative event "Common cause miscalibration of all ECCS pressure transmitters" (ESF-XHE-MC-DF01) was changed from 8.00E-05 to 8.00E-06. This change would simulate the common cause failure combined with the failure of the operator to bypass the permissive. No other basic events or fault tree structures were affected.

As identified in Section E.6.21 of the HCGS Environmental Report, the model change resulted in decreasing the CDF from the base value of 4.44E-6/yr to 4.38E-6/yr (i.e., a decrease of 1.4%).

6.j SAMA 40, which involves providing procedural guidance to bypass the reactor core isolation cooling (RCIC) turbine exhaust pressure trip, was estimated to cost $620K. This cost is appreciably higher than the cost estimate of $250K for Duane Arnold SAMA 166. The Duane Arnold SAMA is also similar to, and the source of the HCGS SAMA 40. Provide justification for the implementation cost estimate for SAMA 40.

PSEG Response:

A table was prepared for each SAMA that included cost estimates and a summary of the SAMA changes. This table is provided for SAMA 40. This SAMA involves the installation of six key-lock switches to bypass various low pressure permissives. Since it involves multiple permissives, the benefit can not be obtained without installing key-lock switches due to the time required to install six jumpers when compared to the time to operate six key-lock switches. The cost estimate is justified.

SAMA 40: Install Manual Bypass of ECCS Low Pressure Permissive	
Engineering	$400,000
Material	$50,000
Installation	$100,000
Licensing	$0
Critical Path Impact	$0
Simulator Modification	$20,000
Procedures and Training	$50,000
Total Cost	$620,000
Summary:	
This SAMA involves the installation of six key-lock switches to bypass various low pressure permissives. Since it involves multiple permissives, the benefit can not be obtained without installing key-lock switches due to the time required to install six jumpers when compared to the time to operate six key-lock switches. This SAMA involves safety-related permanent plant modifications.	

6.k SAMAs 33 and 34, which involve cross-tieing the 480V AC buses at HCGS, are each estimated to cost $1.32M to. Wolf Creek SAMA 3 and Susquehanna SAMA 2a, which also involve cross-tieing 4kV AC buses, are estimated to cost $328K and $656K, respectively. Provide a more detailed description of both the modification and the implementation cost estimate for HCGS SAMAs 33 and 34.

PSEG Response:

A table was prepared for each SAMA that included cost estimates and a summary of the SAMA changes. These tables are provided for SAMAs 33 and 34. Both SAMAs install new tie-breakers and cables for the associated 480VAC bus cross-ties. Most of the cost for each SAMA is related to Engineering. The Engineering costs are significant due to the electrical load analysis required to support the cross-ties. It may be possible to share some of the Engineering costs between SAMAs 33 and 34. The cost estimates are justified.

SAMA 33: Install Cross-Ties Between Division II 480VAC Buses	
Engineering	$800,000
Material	$200,000
Installation	$200,000
Licensing	$50,000
Critical Path Impact	$0
Simulator Modification	$20,000
Procedures and Training	$50,000
Total Cost	$1,320,000
Summary:	
This SAMA installs new tie-breakers and cables for the 480VAC bus cross-ties. The Engineering costs are significant due to the electrical load analysis required to support the cross-ties. It may be possible to share some of the Engineering costs with SAMA 34. This SAMA involves permanent safety-related plant modifications.	

SAMA 34: Install Cross-Ties Between Division I 480VAC Buses	
Engineering	$800,000
Material	$200,000
Installation	$200,000
Licensing	$50,000
Critical Path Impact	$0
Simulator Modification	$20,000
Procedures and Training	$50,000
Total Cost	$1,320,000
Summary:	
This SAMA installs new tie-breakers and cables for the 480VAC bus cross-ties. The Engineering costs are significant due to the electrical load analysis required to support the cross-ties. It may be possible to share some of the Engineering costs with SAMA 33. This SAMA involves permanent safety-related plant modifications.	

7. For certain SAMAs considered in the ER, there may be lower-cost alternatives that could achieve much of the risk reduction at a lower cost. In this regard, provide an evaluation of the following SAMAs:

7.a Establishing procedures for opening doors and/or using portable fans for sequences involving room cooling failures (SAMAs 14, 16, 17, and 18).

PSEG Response:

As described in the response to RAI 6.e, HCGS already has procedures to align portable fans on loss of normal Switchgear Room HVAC. This event is included and credited in the PRA model and no additional evaluation is required beyond what was provided for SAMA 16 in the ER.

SAMAs 14, 17, and 18 are all related to mitigating failures of Service Water Pump Room HVAC. While the ER demonstrated that SAMAs 17 and 18 are potentially cost effective enhancements, implementing an alternate room cooling strategy is considered to be a more practical and cost effective change. This proposed SAMA, designated as SAMA RAI 7.A-1, will be evaluated in parallel with cost effective SAMAs 17 and 18, since there may be some benefit associated with a permanent hardware modification.

The following table provides a cost estimate for developing an alternate room cooling strategy for the Service Water Pump Room:

SAMA RAI 7.a-1:	**Enhance Procedures and Provide Additional Equipment to Respond to Loss of All Service Water Pump Room Supply or Return Fans**
Engineering	$50,000
Material	$50,000
Installation	$25,000
Licensing	$0
Critical Path Impact	$0
Simulator Modification	$0
Procedures and Training	$25,000
Total Cost	$150,000
Summary:	
A common cause failure could cause loss of all Service Water Pump Room supply or return fans since the supply fans have the same design and the return fans also have the same design. This SAMA mitigates such a failure by opening doors and installing fans to establish an alternate air flow. The Engineering work includes the determination of the air flow path from the Service Water Pump Rooms to the external environment, the requirements for portable fans and ducting, and potential impact to other requirements such as Fire Protection. Installation includes a dry-run to ensure functionality. This SAMA does not involve permanent plant modifications.	

Sections E.6.10 and E.6.11 provide estimates of the benefits associated with eliminating the Service Water Pump Room HVAC failures. Section E.6.10 addresses the mitigation of supply path failures (SAMA 17) and section E.6.11 addresses the mitigation of the return path failures (SAMA 18). Because SAMA RAI 7.a-1 would mitigate both the supply and return failures, the averted cost-risk for this SAMA is the sum of the averted cost-risks calculated for SAMAs 17 and 18:

$$\text{Averted Cost-Risk}_{\text{ER baseline}} = \$963{,}446 + \$963{,}446 = \$1{,}926{,}892$$

In order to account for the increase in the External Events multiplier that would result from the use of the LLNL seismic hazard curves in place of the EPRI curves, this value is multiplied by the ratio of the External Events multiplier developed in the response to RAI 5.j to the multiplier originally developed in the ER:

$$\text{Averted Cost-Risk}_{\text{LLNL baseline}} = \$1{,}926{,}892 * 6.8/6.3 = \$2{,}079{,}820$$

If the 95th percentile PRA results are considered, the averted cost risk is increased to $5,906,689. The net value for SAMA RAI 7.a-1 is positive by a large margin, which implies that this proposed SAMA is cost beneficial:

Net Value = $5,906,689 - $150,000 = $5,756,689

7.b Extending the procedure for using the B.5.b low pressure pump for non-security events to include all applicable scenarios, not just SBOs. Clarify if this is the intent for SAMA 10 or not.

PSEG Response:

The scope of SAMA 10 includes using the B.5.b low pressure pump to mitigate any applicable non-security scenario, which is consistent with the SAMA 10 quantification performed in the HCGS ER. No additional quantification is required.

7.c Utilizing a portable independently powered pump to inject into containment.

PSEG Response:

The HCGS PRA already credits injection to the RPV and containment using the diesel fire pump (with a fire pumper truck for pressure boosting). For cases in which an injection pathway to the RPV/containment is available (e.g., early containment failure has not failed the injection lines), the failure of injection with the fire protection system is dominated by the operator alignment error. Addition of another independently powered injection source would have limited impact on the reliability of containment injection.

Further, SAMA 10, which is evaluated in the ER, could be used for this function. No additional evaluation of independently powered containment injection pumps is required.

8. PSEG's cost-benefit analysis showed that nine of the SAMA candidates (SAMAs 1, 3, 4, 10, 17, 18, 30, 35, and 39) were potentially cost-beneficial in the baseline analysis and that an additional four SAMAs (SAMAs 8, 32, 36, and 37) were potentially cost-beneficial based on the results of the sensitivity analysis. In view of the significant number of potentially cost-beneficial SAMAs, it is likely that several of these SAMAs address the same risk contributors. As such, implementation of an optimal subset of these SAMAs could achieve a large portion of the total risk reduction at a fraction of the cost, and render the remaining SAMAs no longer cost-beneficial. In this regard: identify those SAMAs that PSEG considers highest priority for implementation, provide a revised cost-benefit analysis assuming these high priority SAMAs are implemented, and identify those SAMAs that would no longer be cost-beneficial given implementation of the high-priority SAMAs. Also, provide any specific plans/commitments regarding implementation of the high priority SAMAs.

PSEG Response:

The response consists of two parts. The first part describes the processes used to evaluate potentially cost-beneficial SAMAs. The second part details the SAMA implementation strategy.

Evaluation of Potentially Cost-Beneficial SAMAs

The following processes are used in the review of potentially cost-beneficial SAMAs.

- Plant Health Committee Process – Used to structure the review of the potentially cost-beneficial SAMAs.
- Issue Identification and Screening Process – Used for action tracking of procedure revision requests, design change requests, and engineering work requests.
- Processing of Procedures – Used for implementing procedure revisions.
- Configuration Control Process – Used for implementing design changes.

Each of the potentially cost-beneficial SAMAs will be presented to the Plant Health Committee (PHC). This committee is chaired by the Plant Manager. Members include the Plant Engineering Manager, Director – Operations, Director – Engineering, Director – Maintenance, and Director – Work Management. The PHC is chartered to review issues that require special plant management attention to ensure effective resolution. With respect to potentially cost-beneficial SAMAs, the committee will decide on one of the following six actions for each SAMA.

Approved for Implementation

1. The SAMA consists entirely of a procedure revision for which the technical basis exists. A procedure revision request will be initiated to implement the SAMA via the normal procedure revision process.

2. The SAMA consists of a design change with well-defined cost. A design change request will be initiated to implement the SAMA via the normal design change process.

Conditionally Approved for Implementation

1. The SAMA consists entirely of a procedure revision for which the technical basis does not yet exist. An engineering work request will be initiated to develop the technical basis. The technical basis will be evaluated by PHC to decide whether to continue with implementation. It is possible that the technical basis can not be developed as described in the SAMA. In this case, the SAMA may not be cost-beneficial and thus will not be implemented. If implementation will continue, a procedure revision request will be initiated to implement the SAMA via the normal procedure revision process.
2. The SAMA consists of a design change that does not have a well-defined cost but the cost is low. A design change request will be initiated to implement the SAMA via the normal design change process but there will be an evaluation by PHC at the 30% completion milestone to decide whether to continue with implementation. At the 30% completion milestone, the detailed design is basically complete. It is possible that the detailed design will show the SAMA is not cost-beneficial and thus will not be implemented.
3. The SAMA consists of a design change that does not have a well-defined cost and the cost is high. An engineering work request will be initiated to perform a conceptual design. PHC will review the completed conceptual design and decide whether to continue with implementation. It is possible that the conceptual design will show the SAMA is not cost-beneficial and thus will not be implemented. If implementation will continue, a design change request will be initiated to implement the SAMA via the normal design change process.

Disapproved

1. The SAMA will not be implemented.

It is possible that a SAMA could be tabled by the PHC awaiting additional information. The information request would likely fall into one of the following categories.

- PHC identified a correction that needs to be made in the SAMA analysis. The impact of this correction needs to be determined.
- PHC identified an alternate solution that will meet the SAMA goal at a lower cost. This alternate solution needs to be examined.
- PHC requests a PRA sensitivity study to determine the effect of implementing a specified SAMA subset on this SAMA.

- PHC requests a PRA sensitivity study to determine the effect of already approved SAMAs on this SAMA.
- PHC requests a PRA sensitivity study to determine the effect of already approved non-SAMA design changes on this SAMA.
- PHC requests coordination of this SAMA with related Mitigating System Performance Index (MSPI) margin recovery activities. The details of this coordination need to be presented to PHC.

A tabled SAMA will be re-presented to the PHC when the requested information has been assembled. At the completion of the PHC review, there will be no tabled SAMAs.

Each PHC decision and its rationale will be documented in the minutes of the associated PHC Meeting.

Implementation of Potentially Cost-Beneficial SAMAs

PRA sensitivity studies to find the optimal subset of potentially cost-beneficial SAMAs were not performed due to the large number of possible combinations. One of the purposes of the review of the potentially cost-beneficial SAMAs by the Plant Health Committee (PHC) is to identify potential synergies between SAMAs using the wide breadth of plant knowledge available on the PHC. The PHC can request targeted sensitivity studies to better understand these synergies.

The SAMAs that are "Approved for Implementation" or "Conditionally Approved for Implementation" will be ranked with respect to priority and assigned target years for implementation. They will be scheduled consistent with this priority structure and in accordance with the normal budgetary and work management processes. The implementation schedule may include "hold points" for PRA model updates and determination of the effect on the remaining SAMAs. Thus, the PRA model evolves with the plant and the impact on risk for SAMAs considered for potential implementation are evaluated based on the latest available PRA model of record.