PSEG Nuclear LLC
P.O. Box 236, Hancocks Bridge, NJ 08038

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AUG 18 2010

10 CFR 50
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LR-N10-0308

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

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

Subject: Supplement to RAI responses submitted in PSEG letter LR-N10-0181 dated June 1, 2010, related to the Severe Accident Mitigation Alternatives (SAMA) review of the Hope Creek Generating Station

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. Paul J. Davison (PSEG Nuclear, LLC) "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

3. Teleconference held on July 29, 2010 between the USNRC Staff and PSEG Nuclear regarding clarifications to the RAI responses provided in the Reference 2 letter.

In the Reference 1 letter, the NRC requested additional information related to the Severe Accident Mitigation Alternatives (SAMA) review of the Hope Creek Generating Station. In the Reference 2 letter, PSEG responded to the NRC's requests for additional information related to SAMA. In the Reference 3 teleconference the NRC Staff sought clarification pertaining to some of the PSEG SAMA RAI responses. The enclosed supplement provides that clarification.

This letter and its enclosure contain no regulatory commitments.

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If there are questions, please contact Helen Gregory, Environmental Manager, PSEG Nuclear, at 856-339-1341.

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

Executed on 8/18/10

Sincerely,

Christine T. Neely
Director, Regulatory Affairs
PSEG Nuclear LLC

Enclosure: Supplement to SAMA RAI Responses

cc: Regional Administrator – USNRC Region I
C. Eccleston, Environmental Project Manager, License Renewal – USNRC
R. Ennis, Project Manager - USNRC
NRC Senior Resident Inspector – Hope Creek
P. Mulligan, Manager IV, NJBNE
L. Marabella, Corporate Commitment Tracking Coordinator
T. Devik, Hope Creek Commitment Tracking Coordinator

Enclosure

Supplement to RAI responses submitted in PSEG letter LR-N10-0181 dated June 1, 2010, related to the Severe Accident Mitigation Alternatives (SAMA) review of the Hope Creek Generating Station (HCGS)

NOTE: A list of acronyms and abbreviations used in this response is provided at the end of this supplement.

1. **Clarification requested regarding RAI 1.d.**

   a. On Page E-54 of the ER, eight supporting requirements are indicated to not have been met. Only six are addressed in the response to this RAI. Clarify the discrepancy.

PSEG Response:

The summary results on Page E-54 of the HCGS License Renewal Environmental Report are identified to be based on the draft Hope Creek PRA Peer Review report. The draft PRA Peer Review Report identified eight supporting requirements (SRs) that were not met. The final PRA Peer Review Report included modifications to the draft report and concluded that six SRs were not met. The response to RAI 1.d addressed the six SRs that were not met based on the final PRA Peer Review Report.

The number of SRs that are assigned to Capability Category 2 increased from 35 in the draft report to 37 in the final report. All other SR capability category results remained the same.

   b. The discussion of the resolution of the findings for SR SC-A6 appears to imply that both the diesel driven fire pump and the fire pumper truck, used in tandem, are necessary to provide injection into the RPV. Clarify the success criteria requirements and how the PRA models these requirements.

PSEG Response:

Yes, both the diesel driven fire pump (DFP) and the fire pumper truck, used in tandem, are necessary to support the success criteria to provide injection into the RPV. This is based on PSEG calculations in order to achieve the necessary system flow and pressure.

The PRA model includes failures of either the DFP or the fire pumper truck as failure for the credited scenarios. The PRA model includes several failure modes for failure of either the DFP or the fire pumper truck, including: operator failure to perform the manual alignment in time, hardware failure or maintenance unavailability of the DFP or the fire pumper truck, hardware failure or maintenance unavailability via the LPCI injection crosstie path, and internal flooding induced failure of the fire protection system piping.

2. **Clarification requested regarding RAI 1.e.**

Describe the criteria used to determine if plant modifications or procedure changes require a PRA model update. The conclusion that an upgrade is not necessary should be based on an assessment that none of the changes would impact the conclusions of the SAMA analysis rather then the other way around as is implied by the RAI response.

PSEG Response:

Per PSEG procedures, in addition to periodic PRA updates, an unscheduled PRA model update is required if a plant modification or procedure change resulted in a significant change in CDF or LERF (e.g., greater than 25% change), a significant change in accident class results contribution (e.g., greater than factor of 2 change), or a significant change in Online Maintenance risk colors. With respect to the SAMA analysis, it is clarified that a PRA upgrade was not necessary because none of the plant or procedure changes since the HC108B PRA update would impact the conclusions of the SAMA analysis.

3. Clarification requested regarding RAI 5.a.

While the approach taken for identifying SAMAs that reduce the importance of initiating events by addressing other failures in the initiating event sequences will identify valid SAMA candidates, there might be additional, potentially more cost effective SAMAs that reduce the frequency of the initiating event itself rather then other failures in the sequences. This may be true, particularly if the site-specific contribution to the initiating event frequency includes a failure that might be easily mitigated. Discuss this aspect of the identification of SAMAs for important initiating events and provide assurance that a review of the contributors to the initiating event frequencies has been made and there are no such viable SAMAs.

PSEG Response:

Site-specific contributions to the initiating event frequencies that pose a unique vulnerability are typically captured and corrected within existing processes, e.g., the corrective action program can result in procedure changes, plant modifications, and training enhancements aimed at precluding further recurrence. When considering other existing plant processes, the SAMA analysis is not the only mechanism for mitigating site-specific contributors, but rather just one method of identifying risk-important events based on what is represented in the PRA, which represents existing plant hardware, configuration and operational procedures.

However, for initiating events that were modeled using fault trees, a more detailed assessment of the dominant contributors can be made by examining their associated cutsets. There were two initiators in the PRA that used the fault tree approach, which were the Reactor Auxiliaries Cooling System (RACS) and the Safety Auxiliaries Cooling System (SACS) systems.

The initiator for loss of RACS was of relatively low importance, appearing in the base model cutsets with a cutset probability of 1.5E-12. The RRW for %IE-RACS was listed as 1.000. Therefore, no postulated SAMAs are necessary for the RACS initiator.

For the loss of SACS initiating event (%IE-SACS), the RRW was 1.02, so a review of the initiator fault tree cutsets was warranted to gain information on the dominant contributors to this initiator. Based on this review, about 90% or more of the cutset frequencies could be attributed to run failures or other unavailabilities of the SACS pumps. To mitigate this plant-specific initiator contribution and provide for increased reliability of the SACS system, SAMA 42 was postulated that involved installation of a standby diesel-powered pump in the SACS system.

SAMA 42: Installation of SACS Standby Diesel-Powered Pump

Since 90% of the initiator frequency was attributed to unavailability failures of the SACS pumps, it was determined that in order to estimate the maximum averted cost for this SAMA, the initiator value for %IE-SACS would be reduced by a factor of 10. This would assume that the diesel-powered SACS pump would be highly reliable and have the capability of being remotely controlled from the Main Control Room. Also, since the success criteria for the Loss of SACS Initiating Event fault tree is 2 out of 4 SACS pumps available, this backup pump would be required to have double the flow capacity of a single currently installed SACS pump.

Assumptions:

1. The diesel-powered standby pump is highly reliable and capable of being quickly put into service from the Main Control Room following a loss of the normally running SACS pumps.

2. Installation of this backup diesel-powered pump would reduce the initiating event frequency by a factor of 10.

PRA Model Changes to Simulate SAMA:

The initiating event %IE-SACS was changed from 1.16E-4 /yr to 1.16E-5 /yr.

Results of SAMA Quantification:

Implementation of this SAMA yielded relatively small reductions in the CDF, Dose-Risk and Offsite Economic Cost-Risk. The results are summarized in the following table for HCGS:

	CDF	DOSE-RISK	OECR
Base Value	4.44E-06	22.86	$155,055
SAMA Value	4.38E-06	22.57	$152,923
Percent Change	1.5%	1.3%	1.4%

A further breakdown of the Dose-Risk and OECR information is provided in the below table according to release category:

RELEASE CATEGORY	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	TOTAL
$\text{Frequency}_{\text{BASE}}$	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**
$\text{Frequency}_{\text{SAMA}}$	1.83E-07	7.05E-08	1.30E-07	9.39E-07	8.33E-08	3.48E-07	2.16E-07	0.00E+00	2.66E-07	2.39E-07	1.90E-06	**4.38E-06**
$\text{Dose-Risk}_{\text{BASE}}$	3.33	0.99	3.05	8.49	0.92	4.55	1.37	0.00	0.00	0.16	0.00	**22.86**
$\text{Dose-Risk}_{\text{SAMA}}$	3.33	0.97	3.05	8.21	0.92	4.55	1.37	0.00	0.00	0.16	0.00	**22.57**
$\text{OECR}_{\text{BASE}}$	$21,045	$6,888	$14,975	$62,159	$7,694	$31,881	$10,235	$0	$0	$177	$0	**$155,055**
$\text{OECR}_{\text{SAMA}}$	$21,019	$6,789	$14,975	$60,160	$7,686	$31,881	$10,235	$0	$0	$177	$0	**$152,923**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table:

SAMA 42 NET VALUE

UNIT	BASE CASE COST-RISK	REVISED COST-RISK	AVERTED COST-RISK
Hope Creek	$19,807,200	$19,538,159	$269,041

Implementation Cost:

The following table provides the cost breakdown for SAMA 42:

SAMA 42: Installation of SACS Standby Diesel-Powered Pump	
Engineering	$1,500,000
Material	$2,500,000
Installation	$2,000,000
Licensing	$50,000
Critical Path Impact	$0
Simulator Modification	$20,000
Procedures and Training	$100,000
Total Cost	**$6,170,000**
Summary:	
This SAMA involves installation of an additional SACS pump, associated valves, and supporting diesel generator. This backup SACS pump will be powered by a permanent diesel generator housed in an enclosure outside of the Reactor Building. Instrumentation and controls will be installed in the Control Room as well as locally. This SAMA involves safety-related, permanent plant modifications.	

Based on a $6,170,000 cost of implementation for HCGS the nominal net value for this SAMA is -$5,900,959 ($269,041 - $6,170,000), and at the 95th percentile the net value would be as follows:

95th Percentile Net Value = [(2.84 * $269,041) - $6,170,000] = -$5,405,924

Therefore, at the 95th percentile, this SAMA is not cost beneficial and will not require any further disposition.

4. Clarification requested regarding RAI 5.d.

This RAI requests the consideration of the incorporation of a passive containment vent. The response indicates that a major reason for such a design not being feasible is that such a design would limit the flexibility of the use of the vent system. Discuss the feasibility of the option of having a manual bypass in parallel with the passive system.

PSEG Response:

Based on a cost of $5-$6 million in 1992/1993 for a Hardened Torus Vent consistent with Generic Letter 89-16 and the NRC-approved BWROG guidelines (and no impact on the containment design basis), an estimate in excess of $25 million would be expected for a passive design that changes the BWR Mark I containment design basis. It would be a first-time design that could not be reproduced from another Mark I containment. It would require prior NRC approval since it would introduce a new type of accident (no automatic containment isolation with active components). The accident analyses in the Updated Safety Analysis Report dealing with releases from the containment would have to be reanalyzed and updated.

Even though the implementation cost is estimated as being quite high, the following averted cost-risk was evaluated as SAMA 41:

SAMA 41: Installation of Passive Hardened Containment Ventilation Pathway

This SAMA evaluates the risk benefit for installing a completely passive containment vent system that does not require any operator action to function.

Assumptions:

- Installation of a completely passive containment vent with two (2) rupture disks in series to replace the existing containment venting hardware, support systems, and operator actions.
- No credit for isolation of the vent path post-venting to maintain NPSH for pumps taking suction from the suppression pool. To be consistent with the "completely passive vent" configuration without human interaction requested in the NRC RAI, post-venting isolation of the vent path is not credited. This assumption increases the probability for loss of NPSH to the ECCS pumps given post-venting success. It is understood that Hope Creek operators are currently trained to isolate the containment vent path post-venting.

Results of SAMA Quantification:

Implementation of this SAMA decreased from the base SAMA value of 4.44E-6/yr to 3.78E-6 /yr for SAMA 41 (i.e., decrease of 15%). There is a minor increase in CDF due to the adverse impact of uncontrolled successful venting on NPSH for systems taking suction from the suppression pool, but this increase in CDF is offset by the larger decrease in CDF for the failure to vent scenarios as modified to reflect a completely passive containment vent system. Significant decreases were also experienced with Dose-Risk and Offsite Economic Cost-Risk. The results are summarized in the following table for HCGS:

	CDF	Dose-Risk	OECR
Base Value	4.44E-06	22.86	$155,055
SAMA Value	3.78E-06	15.93	$104,317
Percent Change	15.0%	30.3%	32.7%

A further breakdown of the Dose-Risk and OECR information is provided in the below table according to 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**
$Frequency_{SAMA}$	1.83E-07	7.15E-08	1.30E-07	3.02E-07	0.00E+00	3.48E-07	2.14E-07	0.00E+00	1.41E-07	7.18E-09	2.38E-06	**3.78E-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	0.99	3.05	2.65	0.00	4.55	1.36	0.00	0.00	0.00	0.00	**15.93**
$OECR_{BASE}$	$21,045	$6,888	$14,975	$62,159	$7,694	$31,881	$10,235	$0	$0	$177	$0	**$155,055**
$OECR_{SAMA}$	$21,045	$6,888	$14,975	$19,386	$0	$31,881	$10,137	$0	$0	$5	$0	**$104,317**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table:

SAMA 41 NET VALUE

UNIT	**BASE CASE COST-RISK**	**REVISED COST-RISK**	**AVERTED COST-RISK**
Hope Creek	$19,807,200	$13,569,803	$6,237,397

Implementation Cost:

The following table provides the cost breakdown for SAMA 41:

SAMA 41: Installation of Passive Hardened Torus Vent			
Implementation Cost Estimate (Order of magnitude/budgetary, detailed cost estimates not required)			
Total Cost:	> $25,000,000		
Summary:			
The existing Hope Creek Hardened Torus Vent (HTV) was installed in 1992/1993 at a cost between $5 and $6M in response to Generic Letter 89-16, "Installation of a Hardened Wetwell Vent". This Generic Letter resulted from a comprehensive review by the NRC of actions that should be taken to reduce the vulnerability of Mark I containments to severe accident challenges. One such action was installation of hardened wetwell vent capability. Hope Creek has a Mark I containment and thus took the actions to install the required capability. The existing Hope Creek Hardened Torus Vent (HTV) design is based on the Boling Water Reactor Owners' Group (BWROG) guidelines as approved by the NRC. These guidelines include criteria that ensure the design does not compromise the existing containment design basis and that the design provides a means to prevent inadvertent actuation. The HTV design, including the multiple containment isolation valves, satisfies these criteria as documented in NRC Inspection Report 50-354/95-09, "Hope Creek Hardened Vent Inspection" (06/30/95). This inspection report concluded that the Hope Creek HTV was designed in accordance with the NRC-approved BWROG guidelines and supported by a thorough 10 CFR 50.59 review and safety evaluation. The cost to modify the existing Hope Creek HTV to a passive system is estimated to exceed $25M based on the impact to the containment design basis and the high cost of the associated engineering analyses. This SAMA involves safety-related, permanent plant modifications.			

Based on an estimated implementation cost of $25,000,000 for HCGS, the nominal net value for this SAMA is -$18,762,603 ($6,237,397 - $25,000,000), and at the 95th percentile the net value would be as follows:

95th Percentile Net Value = [(2.84 * $6,237,397) - $25,000,000] = -$7,285,793

Therefore, at the 95th percentile, this SAMA is not cost beneficial and will not require any further disposition.

5. Clarification requested regarding RAI 5.j.

a. The evaluation of seismic sequence %IE-SET37 indicates that credit for a SAMA reinforcing the 125V DC panel anchorages is reduced by the possibility that 120 VAC power would be lost and the associated requirement for the operators to control the plant without 120 VAC. The 120 VAC power loss is addressed by SAMAs 36 and 37. While the impact of SAMA 36 is assessed in the evaluation of the SAMA to strengthen the 125V DC panels, the impact of implementing SAMA 37 is not addressed. If SAMA 37 is implemented the benefit of the 125V DC panel SAMA would be increased. Provide a discussion and evaluation of the synergism between these SAMAs.

PSEG Response:

In order to gain any "synergistic" benefit from simultaneously improving the 125V DC panels (1A/B/C/D417) and 120V AC panels (1A/B/C/DJ481), the durability of the 120V AC distribution panels would have to be modified to match the improved HCLFP value of the 125V DC panels. This is to ensure that plant instrumentation would be available to support operation of critical systems when the 125V DC system is maintained available.

The current HCLPF value for the 125V DC panels is 0.57g, which is greater than the 0.5g value that was generally used in the IPEEE to screen equipment as having a "high seismic capacity". Given the fact that the 125V DC panels are already high seismic capacity components, increasing their capacities beyond 0.57g may require extensive redesign and/or replacement of the panels. Similarly, the scope of the changes to the 120V AC panels (current HCLPF value of 0.35g) would extend beyond the improved anchorages and supports that were proposed in the original HCGS License Renewal Environmental Report for SAMA 37.

A difficulty in estimating the scope and cost of the changes that would be required to improve the 125V DC and 120V AC panels is that the available seismic results do not provide sufficient detail to determine the HCLFP value that would be required to mitigate the risk associated with power panel failures. In order to obtain the information about scope of changes required, a new seismic model would have to be developed or the IPEEE model would have to be reconstituted. Neither cost is negligible.

With regard to understanding the "synergy" that exists between the improvements, one must be able to separate the benefit associated with only improving one set of panels and the benefit that would occur by performing both sets of changes so that 120V AC will be available when 125V DC is available beyond its nominal range. If these averted cost-risk components are not separated, the result would be subsidizing one lower impact change with the averted cost-risk of another higher impact change. For the purposes of this RAI response, some rough estimates have been made in an effort to characterize the "synergy" for the combined panel upgrades.

It was assumed in the original HCGS License Renewal Environmental Report that the relatively low cost reinforcements to the panel anchorages and supports could eliminate 90 percent of the potential averted cost-risk (PACR) associated with %IE-SET36. For the purposes of this analysis, it is assumed that these changes would increase the HCLPF value to the "high seismic capacity" threshold of 0.5g. It follows then, that only an additional 10 percent of the PACR would be associated with increasing the seismic capacity of the 120V AC panels above 0.5g to match the 125V DC panel enhancements. This correlates to $176,396 (0.1 * $1,763,960 = $176,396).

As documented in the response to RAI 5.j, improving the 125V DC panels without the 120V AC panel improvements resulted in only mitigating one half of the %IE-SET37 PACR of $310,457 due to plant control difficulties. It follows that the "synergistic" benefit of improving the seismic capacity of the 120V panels above a HCLPF value of 0.5g would be the remaining half of the %IE-SET37 PACR ($155,229).

The total "synergistic" benefit is considered to be the sum of the benefit of improving the 120V AC panels above the 0.5G HCLPF seismic capacity and that of mitigating the remaining half of the %IE-SET37 PACR:

Synergistic Benefit = $176,396 + $155,229 = $331,625

If the 95th percentile PRA results are considered, this value is increased by a factor of 2.84:

Synergistic Benefit$_{\text{(95th percentile PRA Results)}}$ = $331,625 * 2.84 = $941,815

The implementation cost associated with the synergistic benefit is that of improving the seismic capacity of the 120V AC panels to match that of the improved 125V DC panels. The baseline analyses address the improvement of the 120V AC panels to a HCLPF value of 0.5g (assumed) and the 125V DC panels to the higher (and unknown) seismic capacity, so those costs are not included in the "synergistic" implementation cost.

As a result, SAMA 44 was identified to represent the concept of reinforcing the 1E 120V AC Distribution Panels to accommodate the higher HCLPF value of 1g. The implementation costs are estimated in the following table:

SAMA 44: Reinforce 1E 120V AC Distribution Panels to 1.0g Seismic Rating	
Engineering	$500,000
Material	$100,000
Installation	$300,000
Licensing	$0
Critical Path Impact	$0
Simulator Modification	$0
Procedures and Training	$0
Total Cost	**$900,000**
Summary:	
This SAMA involves the installation of angle irons, anchor bolts, internal supports, and external supports to the distribution panels. The estimated costs reflect that reinforcing a Seismic I panel with an already high 'g' rating is not a simple modification. Additionally, the estimated costs assume that the existing distribution panels can be modified to achieve the desired rating of 1.0g. If panel replacement is required to achieve this rating, costs would be significantly higher. The possible need for panel replacement cannot be determined without performing a conceptual design. This SAMA involves safety-related permanent plant modifications.	

Therefore, using the averted cost-risk and implementation cost for SAMA 44 developed above, the 95th percentile net value is:

$941,815 - $900,000 = $41,815

Even though a more thorough and rigorous cost estimate was not readily available, the above exercise showed that SAMA 44 may potentially prove cost beneficial and should be subjected to further scrutiny. As such, SAMA 44 will now be included with the other SAMAs that are presented to the Plant Health Committee when evaluating the disposition of cost beneficial SAMAs.

b. Provide Table 5j-4 that is cited on page 70 but not included.

PSEG Response:

Table 5j-4, which deals with the additional review of Level 1 Internal Events contributors, is presented below:

Table 5j-4
Review of Additional Level 1 Internal Events Contributors

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
SAC-AOV-OO-2457A	1.11E-03	1.005	VALVE HV-2457A FAILS TO CLOSE	About 69 percent of the contributors including this failure include failure to depressurize, which is addressed by SAMA 1. Once depressurization is successfully performed, alternate injection can be used in conjunction with venting for heat removal. In addition, general operator training would have the operators to locally manipulate the valve on loss of function, which is not credited. No additional SAMAs required.
IAS-MDC-FR-K100	6.09E-02	1.005	EIA COMPRESSOR FAILS TO RUN	Failure of the EIA compressor to run could be mitigated by SAMA 3. No additional SAMAs required.
SAC-AOV-OO-2457B	1.11E-03	1.005	VALVE 2457B FAILS TO CLOSE	Similar to SAC-AOV-OO-2457A, a large majority of the contributors, including this failure, involve failure to depressurize, which is addressed by SAMA 1. Once depressurization is successfully performed, alternate injection can be used in conjunction with venting for heat removal. In addition, general operator training would have the operators to locally manipulate the valve on loss of function, which is not credited. No additional SAMAs required.

Table 5j-4
Review of Additional Level 1 Internal Events Contributors

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
%IE-ACD	2.07E-03	1.005	LOSS OF AC BUS D INITIATING EVENT	The "Loss of AC Bus D" initiating event cutsets include a diverse set of contributors. About 12% are related to Core Spray suction strainer plugging, which is addressed by SAMA 15. Many contributors could be addressed by allowing the B.5.b pump to be used for non-security events (SAMA 10), but the benefit would be limited to about 40% of the contributors due to operator dependence issues. An additional 17% could be addressed by SAMA 1 (depressurization failures). No additional SAMAs required.
HPI-XHE-AT-CS	1.10E-01	1.005	CREW BLOWS DOWN BEFORE LVL IS CONTROLLED BY HPCI (3600 GPM)	These events are primarily driven by ATWS with level control failures. Over 56% of the contributors include the failure to bypass the low level MSIV isolation logic. The reliability of the bypass action could be improved by installing a keylock switch to simplify the action's execution (SAMA RAI5j-IE1).
RSP-XHE-SHUTDN	1.10E-01	1.005	OP. FAILS TO CONTROL PLANT USING REMOTE SHUTDOWN PANEL (FLOOD)	This event is directly tied to %FLFPS-CR, which is addressed in the HCGS License Renewal Environmental Report by SAMA 8. No additional SAMAs required.

Table 5j-4
Review of Additional Level 1 Internal Events Contributors

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
%FLSWA-RACS-I	1.43E-06	1.005	FREQ. OF ISOLABLE SW A PIPE RUPTURE IN RACS ROOM	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. The current PRA model conservatively assumes a 0.1 failure probability for a spray event, but no equipment enhancements are required to ensure these valves are available in the relevant flooding events. In addition, the PRA conservatively assumes that all of the 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 condition, these events would no longer remain above the importance review threshold. No additional SAMAs are required.

Table 5j-4
Review of Additional Level 1 Internal Events Contributors

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
%FLSWB-RACS-I	1.43E-06	1.005	FRQ. OF ISOLABLE SW B PIPE RUPTURE IN RACS ROOM	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. The current PRA model conservatively assumes a 0.1 failure probability for a spray event, but no equipment enhancements are required to ensure these valves are available in the relevant flooding events. In addition, the PRA conservatively assumes that all of the 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 condition, these events would no longer remain above the importance review threshold. No additional SAMAs are required.

Table 5j-4
Review of Additional Level 1 Internal Events Contributors

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
IE-LOOP-CND-001	2.40E-03	1.005	CONDITIONAL LOOP GIVEN TRANSIENT W/O LOCA SIGNAL	The top failure scenario involving a conditional LOOP is a reactor building flooding event (about 18%), which is addressed by SAMA 8. Approximately 9 percent include failure to depressurize, which is addressed by SAMA 1. Forty percent of the conditional LOOP contributors are already addressed by a JHEP that includes the failure to align the portable generator. Plant enhancements that would require an operator action as part of the mitigation strategy, such as SAMAs 5 or 10, would have a negligible impact on risk due to human dependence issues. The remaining contributors are generally comprised of portable generator hardware failures and early failures of high pressure injection. A comprehensive SAMA would require the auto alignment of an alternate power source, such as the gas turbine. TMI examined auto alignment of the SBO DG and determined that it would cost over $3 million; 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. No additional SAMAs are proposed for conditional LOOP events.

Table 5j-4
Review of Additional Level 1 Internal Events Contributors

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
NR-ATWS-ADS-INH	1.50E-02	1.005	FAILURE TO INHIBIT ADS DURING AN ATWS (W/O FW)	Over 50% of the contributors with failure to inhibit ADS also include the failure to bypass the low level MSIV isolation logic. The reliability of the bypass action could be improved by installing a keylock switch to simplify the action's execution (SAMA RAI5j-IE1).
QTT-TACS-INFL	1.00E-02	1.005	INAD FLOW FROM TACS TO RFPT LUBE OIL COOLERS	Over 50% of the CDF associated with loss of TACS to the RFPT lube oil coolers is driven by failure to depressurize the RPV. These cases are addressed by SAMA 1. No additional SAMAs required.
%IE-MLRHR	1.44E-05	1.005	Medium LOCA – RHR	Over 75% of the CDF associated with this initiating event is driven by failure to depressurize the RPV. These cases are addressed by SAMA 1. No additional SAMAs required.

Table 5j-4
Review of Additional Level 1 Internal Events Contributors

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
SAC-MDP-TM-SSWB	2.30E-05	1.005	SAC A IN MAINT. COINCIDENT WITH SSW B	About 40% 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. An additional 18% of the contributors could be addressed by SAMA 1 (depressurization failures). 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 5j-4
Review of Additional Level 1 Internal Events Contributors

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ACP-LOG-NO-BC421	3.33E-03	1.005	UV CIR LOG FLT IN LOCL GEN CNTRL PNL 1BC421	Over 90% of the contributors including this event contain failures to align the portable generator or portable generator hardware failures. Alignment of an alternate source of power, such as the gas turbines (SAMA 5), could address some of these scenarios, but 75% of the portable generator failures are related to operator error. The implication is that auto alignment of an alternate power source would be required to significantly reduce these contributors. TMI examined auto alignment of the SBO DG and determined that it would cost over $3 million. 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. No additional SAMAs are proposed to address these events.

Table 5j-4
Review of Additional Level 1 Internal Events Contributors

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ACP-LOG-NO-BC422	3.33E-03	1.005	UV CIRC LOG FLT IN REM GEN CNTRL PNL 1BC422	Over 90% of the contributors including this event contain failures to align the portable generator or portable generator hardware failures. Alignment of an alternate source of power, such as the gas turbines (SAMA 5), could address some of these scenarios, but 75% of the portable generator failures are related to operator error. The implication is that auto alignment of an alternate power source would be required to significantly reduce these contributors. TMI examined auto alignment of the SBO DG and determined that it would cost over $3 million. 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. No additional SAMAs are proposed to address these events.

Table 5j-4
Review of Additional Level 1 Internal Events Contributors

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ACP-LOG-NO-BC652	3.33E-03	1.005	UV CIRCUIT LOGIC FAULT IN PNL 1BC652	Over 90% of the contributors including this event contain failures to align the portable generator or portable generator hardware failures. Alignment of an alternate source of power, such as the gas turbines (SAMA 5), could address some of these scenarios, but 75% of the portable generator failures are related to operator error. The implication is that auto alignment of an alternate power source would be required to significantly reduce these contributors. TMI examined auto alignment of the SBO DG and determined that it would cost over $3 million. 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. No additional SAMAs are proposed to address these events.

Table 5j-4
Review of Additional Level 1 Internal Events Contributors

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ESF-LOG-NO-ELSB	3.33E-03	1.005	FAULTS IN ELS TRAIN B LOGIC CIRCUIT	Over 90% of the contributors including this event contain failures to align the portable generator or portable generator hardware failures. Alignment of an alternate source of power, such as the gas turbines (SAMA 5), could address some of these scenarios, but 75% of the portable generator failures are related to operator error. The implication is that auto alignment of an alternate power source would be required to significantly reduce these contributors. TMI examined auto alignment of the SBO DG and determined that it would cost over $3 million. 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. No additional SAMAs are proposed to address these events.

6. **Clarification requested regarding RAI 5.m.**

Provide Table 5m-1 that is cited on page 74 but not included.

PSEG Response:

Table 5m-1, which deals with the breakdown of the dose-risk and OECR information according to release category for the postulated SAMA involving automatic alignment of the 480V AC portable generator, is presented below:

Table 5m-1
Results Summary 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**
$Frequency_{SAMA}$	1.84E-07	7.34E-08	1.30E-07	9.61E-07	8.31E-08	3.47E-07	1.98E-07	0.00E+00	2.53E-07	2.38E-07	1.70E-06	**4.17E-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**
$Dose\text{-}Risk_{SAMA}$	3.35	1.01	3.04	8.41	0.91	4.55	1.26	0.00	0.00	0.16	0.00	**22.69**
$OECR_{BASE}$	$21,045	$6,888	$14,975	$62,159	$7,694	$31,881	$10,235	$0	$0	$177	$0	**$155,055**
$OECR_{SAMA}$	$21,160	$7,068	$14,950	$61,600	$7,670	$31,820	$9,365	$0	$0	$176	$0	**$153,810**

7. Clarification requested regarding RAI 6.c.

The response to RAI 6.b indicates that considerable hardware changes at both Salem and HCGS are involved with SAMA 5 to allow the GTG to be aligned with the HCGS buses. The response to RAI 6.c states that the GTG is currently credited in the HC108B model in a limited set of LOOP circumstances. Describe in more detail the added capability for utilization of the GTG associated with SAMA 5 compared to the existing capability, the impact of the modifications associated with SAMA 5 on the circumstances for which the GTG can be credited, and how the existing capability and the added capability are modeled in the HC108B PRA for the sensitivity study mentioned in the RAI response.

PSEG Response:

The existing sensitivity case referenced in the response to RAI 6.c did not account for the considerable hardware changes identified in the response to RAI 6.b related to SAMA 5. The sensitivity case for RAI 6.c assumed 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 of the existing capability (e.g., do not credit GTG during severe weather events due to the need to perform local actions). The existing Hope Creek PRA only credits the Gas Turbine for the following scenarios:

- Grid related LOOP initiating events, which are a subset of various types of LOOP initiating events, and
- LOOP events where core damage does not occur for 4 hours or longer

Another sensitivity case can be performed to credit the GTG, based on the hardware changes, for the following additional scenarios:

- Switchyard Centered LOOP events (due to installing a dedicated transformer)
- Plant Centered LOOP events (due to installing a dedicated transformer)
- Severe weather related LOOP events (due to installing alignment capability from the main Control Room)
- LOOP events with core damage within 30 minutes (due to installing alignment capability from the main Control Room)

Implementation of this revised SAMA configuration to credit recovery for the scenarios identified above yielded a significant reduction in the CDF, Dose-Risk and Offsite Economic Cost-Risk. The results are summarized in the following table for HCGS:

	CDF	DOSE-RISK	OECR
Base Value	4.44E-06	22.86	$155,055
SAMA Value	4.06E-06	20.42	$137,100
Percent Change	8.6%	10.7%	11.6%

A further breakdown of the Dose-Risk and OECR information is provided in the below table according to 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$_{SAMA}$	1.83E-07	5.47E-08	1.30E-07	8.61E-07	8.32E-08	3.48E-07	1.94E-08	0.00E+00	2.39E-07	2.32E-07	1.91E-06	**4.06E-06**
Dose-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-Risk$_{SAMA}$	3.33	0.75	3.05	7.53	0.91	4.55	0.12	0.00	0.00	0.16	0.00	**20.42**
OECR$_{BASE}$	$21,045	$6,888	$14,975	$62,159	$7,694	$31,881	$10,235	$0	$0	$177	$0	**$155,055**
OECR$_{SAMA}$	$18,045	$6,888	$14,975	$60,590	$7,694	$31,782	$9,664	$0	$0	$177	$0	**$149,815**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table:

SAMA 5 REVISED NET VALUE

UNIT	BASE CASE COST-RISK	REVISED COST-RISK	AVERTED COST-RISK
Hope Creek	$19,807,200	$17,575,835	$2,231,365

Based on a $2,050,000 cost of implementation for HCGS, which assumes that SAMA 2 for Salem would already be implemented, the nominal net value for this SAMA is $181,365 ($2,231,365 - $2,050,000), which results in this SAMA now being cost beneficial.

Therefore, SAMA 5 will now be included with the other SAMAs that are presented to the Plant Health Committee when evaluating the disposition of cost beneficial SAMAs.

ACRONYMS AND ABREVIATIONS

ACRONYM OR ABREVIATION	DEFINITION
AC	alternating current
ACP	AC power
ADS	automatic depressurization system
ASME	American Society of Mechanical Engineers
ATWS	anticipated transient without scram
BWR	boiling water reactor
BWROG	Boiling Water Reactor Owners' Group
CDF	core damage frequency
CET	containment event tree
DC	direct current
DFP	diesel driven firewater pump
DG	diesel generator
ECCS	emergency core cooling system
EDG	emergency diesel generator
EIA	emergency instrument air
FW	feed water
GTG	gas turbine generator
HCGS	Hope Creek Generating Station
HCLPF	High Confidence, Low Probability of Failure
HTV	hardened torus vent
IPEEE	individual plant examination of external events
LERF	large, early release fraction [or frequency]
LOCA	loss of coolant accident
LOOP	loss of offsite power

ACRONYMS AND ABREVIATIONS

ACRONYM OR ABREVIATION	DEFINITION
LPCI	low pressure coolant injection
MSIV	main steam isolation valve
NEMA	National Electrical Manufacturers Association
NPSH	net positive suction head
OECR	offsite economic cost risk
PACR	partial averted cost risk
PRA	probabalistic risk assessment
RACS	reactor auxiliaries cooling system
RAI	request for additional information
RFPT	reactor feedwater pump turbine
RHR	residual heat removal
RPV	reactor pressure vessel
RRW	risk reduction worth
SACS	safety auxiliaries cooling system
SAMA	severe accident mitigation alternative
SBO	station blackout
SSW	standby service water
SW	service water
TACS	turbine auxiliary cooling system
TMI	Three Mile Island Generating Station
V AC	volts alternating current
V DC	volts direct current
W/O	without