release categories included in the review account for about 97 percent of the dose-risk while accounting for only about 20 percent of the Level 2 frequency. Exclusion of the other results from the Level 2 review allows the contributors that are most important to dose-risk and cost-risk to rise to the top of the importance list.

Further grouping of the release categories was required given that the consequences of the ST2 release category are low relative to those for ST1 and ST5. A separate importance list was developed for ST2 to ensure that its contributors could be reviewed without masking the important events in the ST1 and ST5 release categories.

The Level 2 split fractions were also reviewed down to the 1.01 level.

Tables F.5-2a and F.5-2b document the disposition of each split fraction in the Level 2 RRW lists with RRW values greater than 1.01.

It should be noted that the DCPP Severe Accident Mitigation Guidelines provide further actions to mitigate and recover from severe accidents. The types of actions proceduralized include spraying and/or flooding the containment breakpoint to reduce airborne releases, using a fire truck to provide a pumping source for steam generator makeup (or for spraying containment), starting the EDGs without a DC power source, flooding containment to provide core debris cooling/release scrubbing, etc. These types of strategies are not included as SAMAs because they are already implemented at the site.

F.5.1.3 Industry SAMA Review

The SAMA identification process for DCPP is primarily based on the PRA importance listings, the IPE, and the IPEEE. In addition to these plant-specific sources, selected industry SAMA submittals were reviewed to identify any Phase II SAMAs that were determined to be potentially cost beneficial at other plants. These SAMAs were further analyzed and included in the DCPP SAMA list if they were considered to address potential risks not identified by the DCPP importance list review.

While many of the industry SAMAs reviewed are ultimately shown not to be cost beneficial, some are close contenders and a small number have been estimated to be cost beneficial at other plants. Use of the DCPP importance ranking should identify the types of changes that would most likely be cost beneficial for DCPP, but review of selected industry Phase II SAMAs may capture potentially important changes not identified for DCPP due to PRA modeling differences or SAMAs that represent alternate methods of addressing risk. Given this potential, it was considered prudent to include a review of selected industry Phase II SAMAs in the DCPP SAMA identification process.

Phase II SAMAs from the following United States nuclear power sites have been reviewed:

- Susquehanna (Reference 62, Reference 69)
- Shearon Harris (Reference 5, Reference 70)
- H.B. Robinson (Reference 4, Reference 71)
- Point Beach (Reference 15, Reference 72)
- Prairie Island (Reference 16, Reference 73)
- Wolf Creek (Reference 65, Reference 74)
- Grand Gulf (Reference 76, Reference 77)
- Seabrook (Reference 78, Reference 79)

Two General Electric BWR and six Westinghouse PWR sites were chosen from available documentation to serve as the potential Phase 2 SAMA sources. Many of the industry Phase 2 SAMAs were already represented by other SAMAs in the DCPP list, were known not to impact important plant systems or be relevant to the DCPP design, or were judged not to have the potential to be close contenders for DCPP. As a result, they were not added to the DCPP SAMA list. If there were any unique SAMAs that were considered to have the potential to be cost effective for DCPP, they were added to the list. The potentially cost effective SAMAs for each of the sites identified above are reviewed in the following subsections.

F.5.1.3.1 Susquehanna Steam Electric Station

Review of SSES Cost Beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for DCPP	Disposition for DCPP SAMA List
2a	Improve Cross-Tie Capability Between 4KV AC Emergency Buses (A-D, B-C)	SSES did not credit cross-tie between EDG trains and relied on the swing EDG to mitigate EDG failures. DCPP hardware and procedures provide the capability to cross-tie any of the vital 4KV buses, including the vital buses from the opposite unit. The PRA model conservatively does not credit the inter-unit cross-tie capability.	Not included – already implemented.
6	Procure Spare 480V AC Portable Station Generator	This SAMA was developed to address the hardware failure contribution from their existing portable 480V generator. A form of the portable generator SAMA is included on the DCPP list (SAMA 12), but the SAMA is expanded to meet the site specific needs for SBO mitigation.	Already included.
2b	Improve Cross-Tie Capability Between 4KV AC Emergency Buses (A-BC-D)	This SAMA is an enhancement over SSES SAMA 2a and allows cross-tie between any EDG division. See explanation provided above for SAMA 2a.	Not included – already implemented.
3	Proceduralize Staggered RPV Depressurization When Fire Protection System Injection is the Only Available Makeup Source	This SAMA is specific to the SSES site and is based on the need to split flow from a single injection system between units. It is not applicable to the DCPP design.	Not included – not applicable to DCPP.
5	Auto Align 480V AC Portable Station Generator	This SAMA was designed for a plant that already had a portable generator. For DCPP, the generator would support the 125V DC battery chargers, but because the battery life is estimated to be 12 hours, ample time would be available to align the system and the incremental benefit associated with auto alignment is considered to be minimal.	Not included – No significant risk benefit.

F.5.1.3.2 Shearon Harris

Review of Shearon Harris Cost Beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for DCPP	Disposition for DCPP SAMA List
9	Proceduralize Actions to Open EDG Room Doors on Loss of HVAC and Implement Portable Fans	The EDG room HVAC was not a contributor to plant risk in the DCPP PRA importance list review, but the PRA review did analyze the Switchgear Room HVAC (SAMA 6).	Already included.
6	Flood Mitigation for Scenarios 6 and 7	This is a plant specific internal flooding issue related to valve qualification in flooding conditions. The internal events model includes internal flooding contributors, but no issues related to valve qualification or performance were identified in the importance list review for DCPP.	Not included – no significant risk benefit.
8	Alternate Seal Cooling and Direct Feed to Transformer 1B3-SB	This SAMA was developed to address loss of 6.9KV bus events (bus failure) where power is available to the opposite 6.9KV bus, but vital equipment has failed on the powered bus and either RCP seal cooling or the station battery chargers cannot be supported. Bus failures leading to RCP seal failures are not significant contributors to DCPP risk, and SAMA 10 already provides a means of directly providing power to the critical DC loads.	Not included – no significant risk benefit/Already included.

F.5.1.3.3 H.B. Robinson

The H.B. Robinson SAMA analysis used a generic SAMA list as its starting point and few plant specific insights were available that might pertain specifically to Westinghouse PWRs. One of the SAMAs included in the Phase 2 list was, however, related to an important issue at DCPP, which is discussed below.

In addition, NUREG-1437, Supplement 13 (Reference 71) identified two potentially cost beneficial SAMAs that were not identified in the ER, and these have also been included for review.

Review of H.B. Robinson Cost Beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for DCPP	Disposition for DCPP SAMA List
Phase 2 SAMA 8	Create automatic swap over to recirculation on RWT depletion	The swap to recirculation mode is a prominent operator action for most PWRs but automating the process will further improve reliability and reduce the contribution of this action to core damage scenarios. The Phase 1 SAMA list includes this automatic swap to recirculation.	Already included.
1437-13-1	Replace cast-iron yokes on RHR valves	This is a seismic vulnerability specific to the Robinson configuration. No significant risks have been identified at DCPP related to the yokes on the RHR valves and this SAMA would have a negligible impact on DCPP risk.	Not included – no significant risk benefit.
1437-13-2	Install a radiant heat shield on the electrical conduit to the shutdown DG	This is a fire vulnerability specific to the Robinson configuration. The DCPP fire model includes the diesel generators and the dominant risks were reviewed to identify potential SAMAs.	Not included – no significant risk benefit.

F.5.1.3.4 Point Beach

As with H.B. Robinson, this analysis relied on a generic SAMA list and few plant specific insights were available that might pertain specifically to Westinghouse PWRs. The SAMAs identified in the Point Beach submittal as potentially cost effective appeared to be procedural updates to include checkoff provisions within the procedures. Some HRA methodologies credit placekeeping aids in procedures as a means of reducing the potential to skip a step in the cognitive portion of the HEP. While inclusion of such provisions is reflected quantitatively in the PRA, it would be difficult to justify changes to a large number of procedures based on a detail in a specific HRA methodology. This type of SAMA was not included in the DCPP SAMA list. NUREG-1437, Supplement 23 (Reference 72) indicates that when "uncertainties or alternative discount rates" were taken into account, the NRC staff considered the SAMA to "provide portable generators to be hooked into the turbine driven AFW, after battery depletion" (SAMA 169) to be cost beneficial. The use of a portable generator is already included in the DCPP SAMA list (SAMA 10).

F.5.1.3.5 Prairie Island Nuclear Generating Plant

Review of Prairie Island Cost Beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for DCPP	Disposition for DCPP SAMA List
3	Provide alternate flow path from RWST to charging pump suction	The refueling water storage tank (RWST) suction path already includes a pair of redundant valves (Motor Operated Valve (MOV) 8805A/B) for the normal centrifugal charging pumps and the Class 2, third charging pump. The risk-reduction worth (RRW) values for all of the Diablo Canyon Power Plant (DCPP) split fractions (CH*) related to the RWST suction path to the charging pumps are below 1.001 for non-fire events and are not meaningful risk contributors.	Not included – no significant risk benefit.
9	Analyze Room Heat-up for Natural/Forced Circulation (Screenhouse Ventilation)	This SAMA was developed to support the use of alternate room cooling in the plant's screenhouse when normal cooling fails. The DCPP SAMA list includes a SAMA to install an additional train to the Switchgear Room HVAC (SAMA 6).	Already included
19a	Provide a Reliable Backup Water Source for Replenishing the RWST	For Prairie Island, the installation of the RWST refill source is credited primarily for increasing the time that is available to perform RCS cooldown in an SGTR event. Cooldown would equalize primary and secondary side pressures and effectively terminate the inventory loss to the secondary side. DCPP already has the capability to provide makeup to the RWST from the CVCS blend tanks as well as from the spent fuel pool. The RWST refill action is directed in the plant's emergency procedures and credited in the PRA model. Failure of the makeup action is not a risk significant event at DCPP.	Not included – no significant risk benefit.
22	Provide Compressed Air Backup for Instrument Air to Containment	The instrument air system is modeled for DCPP, and the importance review identified the event to provide backup N2 bottles to pressurize the instrument air header (SAMA 5).	Already included

Review of Prairie Island Cost Beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for DCPP	Disposition for DCPP SAMA List
Un-numbered	Purchase a Gagging Device for Closing a Stuck-Open Steam Generator Safety Valve in SGTR Events	As described in PG&E Letter DCL-10-150 (Reference 74), the design of the Dresser type 3700 safety valves used in the DCPP units makes it unlikely that a gagging device would be capable of closing an open safety valve. The valve spindle is not intended to withstand a large compressive force and the expectation is that it would fail (buckle) or cause valve seat damage under the load required to close an open safety valve In addition, for steam generator tube rupture events that lead to core damage, steam and hydrogen will pass from the primary side to the secondary side of the ruptured steam generator and force open the main steam safety valves or PORVs that are not gagged closed, which still leads to a release of radionuclides to the environment. Gagging all of the main steam safety valves is not recommended because it can lead to rupture of the steam generator. Finally, in the event of a stuck open SG PORV, there are manual isolation valves that could be used to terminate the leak.	Not included – not applicable to the DCPP design.

F.5.1.3.6 Wolf Creek Generating Station

Review of Wolf Creek Generating Station Cost Beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for DCPP	Disposition for DCPP SAMA List
2	Modify the Controls and Operating Procedures for Sharpe Station to Allow for Rapid Response	This is a site specific SAMA that was developed to allow the Wolf Creek operators to control a local diesel generating station from the Wolf Creek main control room. This SAMA is not applicable to DCPP.	Not included – not applicable to the DCPP design.
4 (case 2)	Update emergency procedures to direct local, manual closure of the RHR EJHV8809A and EJHV8809B valves if they fail to close remotely	This SAMA was developed to address questions about the ability of MOVs to close against the differential pressure in a specific ISLOCA sequence for Wolf Creek. This SAMA is not applicable to the major DCPP ISLOCA contributors.	Not included – no significant risk benefit.
5	Enhance procedures to direct operators to open EDG Room doors for alternate room cooling	The EDG room HVAC was not a contributor to plant risk in the DCPP PRA importance list review, but the PRA review did analyze the Switchgear Room HVAC (SAMA 6).	Already included.
1	Permanent, Dedicated Generator for the NCP with Local Operation of TD AFW After 125V Battery Depletion	This was designed to assist in an SBO that included a seal LOCA. The installation of the RCP shutdown seals at DCPP, which greatly reduces the likelihood of seal LOCAs, will preclude the need for a SAMA of this type.	Not included – no significant risk benefit.
3	AC Cross-tie Capability	This SAMA is designed to improve AC crosstie capability. DCPP hardware and procedures provide the capability to cross-tie any of the vital 4KV buses, including the vital buses from the opposite unit. The PRA model conservatively does not credit the inter-unit cross-tie capability.	Not included – already implemented.
13	Alternate Fuel Oil Tank with Gravity Feed Capability	For Wolf Creek, fuel oil failures contributed significantly to the CDF and an alternate method to transfer fuel to the EDG day tank was determined to be cost effective. At DCPP, there is already a capability to provide alternate power to the fuel pumps and an engine driven fuel oil pump that can be aligned.	Not included – function met by alternate means.

Review of Wolf Creek Generating Station Cost Beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for DCPP	Disposition for DCPP SAMA List
14	Permanent, Dedicated Generator for the NCP, one Motor Driven AFW Pump, and a Battery Charger	This was designed to assist in an SBO that included a seal LOCA. The installation of the RCP shutdown seals at DCPP, which greatly reduces the likelihood and consequences of seal LOCAs, will preclude the need for a SAMA of this type.	Not included – no significant risk benefit.

F.5.1.3.7 Grand Gulf Nuclear Station

Review of Grand Gulf Cost Beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for DCPP	Disposition for DCPP SAMA List
39	Change Procedure to Cross Tie Open Cycle Cooling System to Enhance Containment Spray System	This SAMA provides appears to provide a means of using an existing connection to an open cycle water system to supply water to the containment spray heat exchangers to reduce containment pressure. This SAMA is not directly applicable to DCPP because the DCPP CS system does not have a heat exchanger and is not used for long term containment heat removal. DCPP does have procedure to align an external water source to containment spray headers in longer term scenarios, but this approach would not provide indefinite heat removal capability.	Not included – not applicable to the DCPP design.
42	Enhance Procedures to Refill Condensate Storage Tank from Demineralized Water or Service Water System	A procedure change to allow the use of existing equipment to provide makeup to the CST and maintain core cooling. At DCPP, this function is met by directly supplying the AFW pump suction header from alternate water sources including the Firewater Tank (seismically qualified, hard piped connection) and the Raw Water Reservoir (non-seismically qualified, hard piped connection).	Not included – function met by alternate means.

Review of Grand Gulf Cost Beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for DCPP	Disposition for DCPP SAMA List
59	Increase operator training for alternating operation of the low pressure ECCS pumps (LPCI and LPCS) for loss of standby service water scenarios	An improvement in the operator training program that provides a means of maintaining RPV injection after failure of cooling water to the ECCS pumps. DCPP has the capability to use Firewater as an alternate high head injection pump cooling source in the event that CCW has failed. In addition, a third non-safety centrifugal charging pump is available to provide makeup that is air cooled and does not require cooling water. For the low pressure pumps, CCW provides both pump seal cooling and cooling to the heat exchangers. If CCW is not available to support recirculation, providing pump seal cooling is not beneficial.	Not included – function met by alternate means.
Un-numbered	Revise procedures to direct the operator monitoring a running diesel generator to ensure that the ventilation system is running or take action to open doors or use portable fans.	A procedure change to improve the likelihood that HVAC failures will be identified and mitigated during EDG operation. These types of failures are not significant contributors to DCPP risk. In addition, DCPP has high room temp and radiator discharge temp alarms with proceduralized responses for each EDG, including alternate room cooling actions to open doors.	Not included – no significant risk benefit.

F.5.1.3.8 Seabrook Station

Review of Seabrook Cost Beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for DCPP	Disposition for DCPP SAMA List
157	Provide independent AC power source for battery chargers; for example, provide portable generator to charge station battery	Ensures availability of long term DC power. Identified as SAMA 12 for DCPP.	Already included.

Review of Seabrook Cost Beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for DCPP	Disposition for DCPP SAMA List
164	Modify 10" condensate filter flange to have a 2-1/2" female fire hose adapter with isolation valve	This SAMA is based on a Seabrook hardware configuration insight that would provide a means of adding inventory to the CST. DCPP already includes alternate connections to Fire Water and Raw Water to support long term AFW operation (rather than refilling the CST).	Not included – function met by alternate means.
165	RWST fill from firewater during containment injection—Modify 6" RWST Flush Flange to have a 2½" female fire hose adapter with isolation valve	This SAMA is based on a Seabrook hardware configuration insight that would provide a means of adding inventory to the RWST. DCPP already has these connections on the RWST.	Not included – already implemented.
172	Evaluate installation of a "shutdown seal" in the RCPs being developed by Westinghouse	DCPP will install generation 3 Westinghouse RCP emergency seals. The PRA model already credits the new seals.	Not included – implementation planned and credited in the PRA.
192	Install a globe valve or flow limiting orifice upstream in the fire protection system	This is a Seabrook-specific enhancement to provide the capability to mitigate fire protection floods in the Control Building. Fire protection flood isolation actions for DCPP are relatively reliable and would not be highly sensitive to changes in diagnosis times resulting from the installation of flow restrictors in the Fire Protection System piping.	Not included – no significant risk benefit.
193	Hardware change to eliminate motor-operated valve (MOV) AC power dependency	Available information indicates that the replacement of an MOV with a "fail-closed" AOV will eliminate the need for manual action to ensure containment isolation when AC power has been lost. The majority of containment isolation valves (CIV) at DCPP are air operated and they fail closed on loss of air. Only a few MOV's are used. These valves would be closed manually in the Loss of all AC EOP. All power-operated CIV's have class 1E powered position indication in the Control Room (either inverter 120VAC or 120VDC). Finally, for DCPP, containment isolation contributors are generally fire events and in those cases, power is not necessarily lost.	Not included – already implemented/ no significant risk benefit.

Review of Seabrook Cost Beneficial SAMAs

Industry Site SAMA ID	SAMA Description	Discussion for DCPP	Disposition for DCPP SAMA List
195	Make improvements to PCCW temperature control reliability	This SAMA appears to reduce Primary Component Cooling Water System failures by replacing the temperature control elements with improved components. DCPP's CCW system (same as PCCW) has no temperature control. The ASW flow must all go through the CCW HX tubes and likewise the CCW flow has no HX bypass provision and all flow must go through the shell side of the CCW HX.	Not included – not applicable to the DCPP design.

F.5.1.3.9 Industry SAMA Identification Summary

The important issues for DCPP are generally considered to be addressed by the SAMAs developed through the PRA importance list review. The plant changes suggested as part of that review were developed to meet the specific needs of the plant such that those SAMAs are more likely to provide effective means of risk reduction than SAMAs taken from other sites. However, effort was made to review other industry SAMA analyses to determine if other sites identified plant changes that could be cost beneficial for DCPP based on modeling differences or other factors. For DCPP, no additional SAMA candidates were identified based on a review of selected industry analyses.

F.5.1.4 DCPP IPE PLANT IMPROVEMENT REVIEW

The DCPP IPE generated a list of risk-based insights and potential plant improvements. Typically, changes identified in the IPE process are implemented and closed out; however, there are some items that are not completed within the industry due to high projected costs or other criteria. Because the criteria for implementation of a SAMA may be different than what was used in the post-IPE decision-making process, these recommended improvements are re-examined in this analysis.

As a result of the IPE review, several potential/completed improvements were identified for consideration that were based on PRA based insights, as well as several other plant enhancements that were not necessarily related to the PRA in origin. In addition, two potential plant improvements identified in the DCPP IPE Safety Evaluation Report (Reference 36) that were not documented as potential plant improvements in the IPE have been included for review. The following table summarizes the status of these improvements:

Status of IPE Plant Enhancements

Description of Potential Enhancement	Status of Implementation	Disposition
EDG Fuel Oil Transfer System: Recirculation lines were added to the diesel generator day tank system in order to allow the system to operate continuously once a start demand was received. Also, provisions were made to allow for manual operation of the level control valves on the diesel generator day tanks and to allow a portable engine-driven pump to be connected to the system.	Implemented	No further review required.
Charging Pump Backup Cooling: For scenarios involving a complete loss of component cooling water, provisions have been made and procedures are in place to allow the use of fire water to cool the centrifugal charging pumps. This design feature allows reactor coolant pump seal injection and consequently reactor coolant pump seal cooling to be maintained for scenarios involving a complete loss of component cooling water.	Implemented	No further review required.
Substation Spare Parts: For seismic events that result in a loss of offsite power due to switchyard equipment failures, spare parts are stored on-site to allow expeditious recovery. This ensures that the parts will be available in a timely manner for use by recovery personnel.	Implemented	No further review required.

Status of IPE Plant Enhancements

Description of Potential Enhancement	Status of Implementation	Disposition
Overcurrent Relay Remote Reset: The 4.16 kV overcurrent relays actuate and trip the breakers to the 4.16 kV vital buses. To facilitate recovery, it was proposed that the seal-in contacts be removed to allow the overcurrent trip to be reset from the control room.	Not Implemented	Upon further investigation, it was determined that the existing capability and procedures to reset these relays from the control room were sufficient; therefore, the proposed modification was not implemented.
Valve Control Switch Replacement: This modification consisted of replacing three-position valve control switches (with spring return to neutral) with two-position valve control switches (with maintained contacts).	Implemented	The change affects component cooling water pump discharge valves and safety injection pump suction valves. The new switches prevent valve position changes due to relay chatter.
Dedicated Sixth EDG: Adding a sixth emergency diesel generator.	Implemented	Completed in 1993. No further review required.
AMSAC System: Provides an alternate and diverse mean of assuring turbine trip and actuating the AFW system.	Implemented	No further review required.
Digital Feedwater Control: Digital control of the feedwater system helps reduce the initiating event frequencies of the transients involving feedwater flow.	Implemented	No further review required.
Boron Injection Tank Elimination: The elimination of the boron injection tank simplified the high pressure ECCS system and removed a potential failure mode of the ECCS, i.e. boric acid clogging in ECCS piping.	Implemented	No further review required.
480 V Switchgear Ventilation: A design change that precluded the potential for a single failure of the motor operated discharge damper to fail the 480 V switchgear ventilation system.	Implemented	No further review required.

Status of IPE Plant Enhancements

Description of Potential Enhancement	Status of Implementation	Disposition
Component Cooling Water Abnormal Operating Procedure Enhancements: Operating Procedure OP AP-11, "Malfunction of Component Cooling Water System" was revised to better ensure that RCP seal cooling would be maintained to prevent RCP seal LOCAs.	Implemented	No further review required.
Eagle 21 Process Protection System Upgrade and Resistance Temperature Detector Bypass: This Eagle 21 upgrade improves the reliability and availability of the plant process protection system. The resistance temperature detector bypass elimination reduces plant downtime and radiation exposures to plant personnel.	Implemented	No further review required.
Instrument Inverter Replacement: Installation of the Eagle 21 Process Protection System necessitated the replacement of the instrument inverters with inverters of increased capacity.	Implemented	No further review required.
Modify reactor coolant drain tank (RCDT) door to allow water to flow more freely into the reactor cavity.	Implemented	Completed during the containment recirculation sump modifications of 2007 (Unit 1) and 2008 (Unit 2).
Incorporate insights from SGTR results into accident management program.	Implemented	Insights from the SGTR results have been incorporated into the DCPP Severe Accident Mitigation Guidelines.

All of the plant changes suggested in the IPE and the IPE SER have been implemented at DCPP or were considered to be insufficient and therefore no further review of these items is required.

F.5.1.5 DCPP IPEEE PLANT IMPROVEMENT REVIEW

Similar to the IPE, any proposed plant changes that were previously rejected based on non-SAMA criteria should be re-examined as part of this analysis. In addition, any issues that are in the process of being resolved should be examined because their resolutions could be important to the disposition of some SAMAs. The IPEEE was used to identify these items.

The following table summarizes the status of the potential plant enhancements resulting from the IPEEE processes and its treatment in the SAMA analysis.

Status of IPEEE Plant Enhancements

DESCRIPTION OF POTENTIAL ENHANCEMENT	STATUS OF IMPLEMENTATION	DISPOSITION
A procedure modification is being evaluated. The control room evacuation procedure (OP AP-8A, Rev. 5) modification would require the reactor coolant pumps to be tripped in the event the control room fire is located in cabinets that could result in loss of CCW or auxiliary saltwater (ASW) systems.	Implemented	No further review required.

The above plant change suggested in the IPEEE is considered to have been implemented and no further review is required.

F.5.1.6 POST IPEEE SITE CHANGES

In addition to performing a review of the IPEEE results, it was necessary to review the changes to the site and surrounding area that were implemented after the completion of the IPEEE to determine if the changes could impact the conclusions of the external events analyses. For fire and seismic events, the PRA model development has accounted for the plant changes relevant to these contributors, such as those related to the NFPA 805 transition. For the non-fire/non-seismic external events, the DCPP staff identified the procedural change to trip the RCPs on evacuation of the control room as the only major change since the submittal of the IPEEE. This change was documented in the IPEEE as a task that would be completed in the near future (see previous section for further details). Therefore no further discussion of DCPP post IPEEE site changes is necessary.

F.5.1.7 "OTHER" EXTERNAL EVENTS IN THE DCPP SAMA ANALYSIS

As identified in Section F.2, DCPP has quantifiable PRA models for both seismic and internal fire contributors. The results of these models were used to identify SAMAs for

DCPP using the same process used for the internal events contributors, which addresses part of the DCPP external events risk. In addition to seismic and internal fire events, the IPEEE analyzed the risk posed by multiple other events. Of those that were relevant to the plant, only a subset was considered to have the potential to credibly impact plant operations. These event types, which were analyzed in the IPEEE, include the following:

- High Wind
- Ship Impact
- Accidental Aircraft Impact
- External Flooding
- Chemical Release
- External Fire

While it is possible that SAMAs could be developed to reduce the risk associated with these types of events, their low core damage frequencies imply that it is unlikely that any such SAMAs could be cost beneficial. This can be demonstrated by comparing the potential averted cost-risk (PACR) for each initiating event type with the dollar value corresponding to the lower review threshold defined in Section F.5.1.1 ($100,000).

The review process is a multi-step evaluation. The first step is to develop a PACR for each of the external events contributors. The PACR represents the cost-risk that could be averted if all risk associated with a given initiating event could be eliminated (similar to a MACR, but for a specific initiating event). In order to develop the PACRs for DCPP, it has been assumed that the non-fire/non-seismic external events CDF is directly proportional to the MACR associated with the event types addressed in the PRA model. It is recognized that the public impact of a core damage event varies depending on the scenario, but because there are no Level 2 or Level 3 results for the external events contributors, an alternate method of estimating the PACRs is required. For example, the PACR for ship impact at the intake structure is assumed to be the internal events, fire, and seismic MACR multiplied by the ratio of the ship impact CDF to the internal events, fire, and seismic CDF: $9,044,457 * 1.90E-08 / 8.64E-05 = $1,989

Once the PACRs are developed for the initiating event categories, they can be compared to dollar value of the review threshold ($100,000). If the PACR is less than the review threshold, then no SAMAs are considered to be warranted and the event type can be screened from further consideration.

The following table summarizes the PACRs that were developed using the above process for each of the relevant non-fire/non-seismic external event contributors for which a CDF was developed. The CDFs for the contributors that were considered to be negligible in the IPEEE (external fires, nearby facility accidents, etc.) are assumed to be smaller than the lowest quantified contributor (ship impact on intake structure). Given that the "ship impact" PACR is about $2,000, no potentially cost beneficial SAMAs are considered to exist for those external event contributors.

Review of External Events Screened in the DCPP IPEEE

Initiating Event Group	Estimated CDF (per yr, site)	PACR (site)	Disposition
High Winds	3.20E-07[3]	$33,498	The PACR is below the minimum expected cost of implementation for a SAMA. Screened from further review.
Ship Impact on Intake Structure	1.90E-08	$1,989	The PACR is below the minimum expected cost of implementation for a SAMA. Screened from further review.
Accidental Aircraft Impact	7.00E-07	$73,277	The PACR is below the minimum expected cost of implementation for a SAMA. Screened from further review.
External Flooding	7.20E-07[4]	$75,370	The IPEEE CDF does not account for the availability of the new self-cooled CCP, which would be available in loss of ASW events. The PACR is below the minimum expected cost of implementation for a SAMA. Screened from further review

[3] This is not a CDF, but an annual exceedance frequency for winds of 200 mph or greater. The IPEEE did not develop a conditional core damage frequency for a high wind event, but the actual CDF would be less than the exceedance frequency.
[4] This frequency does not account for the installation of the self cooled CCP, which would be available in loss of ASW scenarios.

Review of External Events Screened in the DCPP IPEEE

Initiating Event Group	Estimated CDF (per yr, site)	PACR (site)	Disposition
Hazardous Chemical Release	8.00E-07[5]	$83,745	The only contributor for this initiating event was an ammonium hydroxide spill, but ethanolamine has replaced ammonium hydroxide at the site. The CDF for this type of event at DCPP is, therefore, considered to be negligible and no SAMAs are required.

The IPEEE was published prior to September 11, 2001. Since that time, there have been efforts to address intentional aircraft impacts and other sabotage events in other forums. For example, security orders issued to licensees following the events of September 11, 2001 required licensees to implement certain mitigation strategies. Under section B.5.b, DCPP implemented mitigation measures to generally deal with the situation in which large areas of the plant were lost due to fires and explosions, whatever the beyond-design basis initiator and without regard to cost. Accordingly, even though the intentional aircraft attacks and sabotage-related events are outside the scope of the SAMA analysis, the site has already taken steps to mitigate severe accidents that might result from such initiators.

Moreover, the NRC has already included a sabotage/terrorism assessment in the license renewal GEIS (NUREG-1437), Chapter 5. The NRC concludes (at 5-18) that ". . . if such events were to occur, the Commission would expect that resultant core damage and radiological releases would be no worse than those expected from internally initiated events."

Based on the fact that this topic is currently being analyzed in another forum, the NRC's expectation that severe accidents initiated by a terrorist attack can be correlated to other internally initiated events, and given an inherent inability to quantify the probability

[5].The IPEEE hazardous material release risk was based on a spill of ammonium hydroxide; other chemical stored on-site were determined not to pose a risk to the MCR operators. Since the IPEEE was completed, the ammonium hydroxide was replaced by the chemical ethanolamine, which was also determined not to pose a risk to MCR operators.

of hypothetical aircraft impacts and other terrorist-initiated events, intentional aircraft impacts and other terrorist-initiated events are not considered further in the DCPP SAMA analysis.

The hazardous chemical release contribution in the IPEEE was based on a spill of ammonium hydroxide from one of the several tanks located on-site. Since the completion of the IPEEE, ammonium hydroxide has been replaced by the chemical ethanolamine. The IPEEE indicates that ethanolamine was being evaluated as a candidate to replace ammonium hydroxide at the time of the analysis and that ethanolamine posed no risk to the MCR operators. Based on the removal of the only chemical identified as a potential risk to MCR operators, the hazardous chemical release CDF for the currently plant configuration is considered to be negligible and no SAMAs are required to address this type of event.

In summary, no SAMAs have been developed to specifically address the risk related to the “other” external events contributors at DCPP.

F.5.2 PHASE 1 SCREENING PROCESS

The initial list of SAMA candidates is presented in Table F.5-3. The process used to develop the initial list is described in Section F.5.1.

The purpose of the Phase 1 analysis is to use high-level knowledge of the plant and SAMAs to preclude the need to perform detailed cost-benefit analyses on them. The following screening criteria were used:

- Applicability to the Plant: If a proposed SAMA does not apply to the DCPP design, it is not retained. Similarly, any SAMAs that have already been implemented by PG&E or achieve results that PG&E has achieved by other means can be screened as they are not applicable to the current plant design. The use of these criteria is not often explicitly used in the Phase I analysis because the SAMA methodology generally precludes inclusion of such SAMAs; however, they are listed as a possible screening method given that there may be circumstances in which a SAMA would be included in the list even if it is not relevant to the site. An example may be the inclusion of a high profile SAMA that is well known in the industry, but not applicable to the specific site design. Such a SAMA may be included for documentation purposes. Another example may be an unimplemented SAMA from the IPE that has been superseded by another plant enhancement.

- Implementation Cost Greater than Screening Cost: If the estimated cost of implementation is greater than the modified MACR (refer to Section F.4.6), the SAMA cannot be cost beneficial and is screened from further analysis.

Table F.5-3 provides a description of how each SAMA was dispositioned in Phase 1. Those SAMAs that required a more detailed cost-benefit analysis are passed to the Phase 2 analysis and evaluated in Section F.6. Table F.6-1 contains the Phase 2 SAMAs.

F.6 PHASE 2 SAMA ANALYSIS

The SAMA candidates identified as part of the Phase 2 analysis are listed in Table F.6-1. The base PRA model was manipulated to simulate implementation of each of the proposed SAMAs and then quantified to determine the risk benefit. Truncation values and binning cutoffs are the same as used in the base PRA model (CDF, LERF, Seismic and Fire), including Level 2 endstates.

In general, in order to maximize the potential risk benefit due to implementation of each of the SAMAs, the failure probabilities assigned to new basic events, such as HEPs, were optimistically chosen so as not to inadvertently screen out any potential cost-beneficial SAMAs. Also, any new model logic that was added to the PRA model in order to simulate SAMA implementation was also simplified and optimistically configured to achieve the same effect.

Determination of the cost-risk benefit for each of the Phase 2 SAMAs involved calculating what was known as the averted cost-risk, which was obtained by comparing the cost risk associated with the plant configuration in which the SAMA has been implemented to the base case MACR value. This value is then compared with the cost of implementation to determine the overall net benefit. That is, the net value is determined by the following equation:

Net Value = (baseline cost-risk of plant operation (MACR) – cost-risk of plant operation with SAMA implemented) – cost of implementation

If the net value of the SAMA is negative, the cost of implementation is larger than the benefit associated with the SAMA, and the SAMA is not considered cost beneficial. The baseline cost-risk of plant operation was derived using the methodology presented in Section F.4. The cost-risk of plant operation with the SAMA implemented is determined in the same manner with the exception that the revised PRA results reflect implementation of the SAMA.

The implementation costs used in the Phase 1 and 2 analyses consist of DCPP specific estimates developed by the plant's cost estimator. The estimates are conceptual in nature based on the conceptual scope of the designs provided to the estimator by the SAMA team. It should be noted that DCPP specific implementation costs are in 2014 dollars with no allowances for escalation, and no consideration for escalation during implementation. In addition, the estimates:

- Do include contingency costs for unforeseen difficulties,
- Do not account for any replacement power costs that may be incurred due to consequential shutdown time,
- Do account for costs for training and procedure revisions,
- Do account for costs for simulator modifications.

Table F.5-3 provides implementation costs for each Phase 1 and Phase 2 SAMA.

The following sections describe the simplified cost-benefit analysis that was used for each of the Phase 2 SAMA candidates. It should be noted that DCPP units 1 and 2 are essentially identical in design and operation (see Section F.2.1 for further discussion). Such differences that do exist are not significant from a risk perspective. As such, the site interim PRA model (DC03), which references Unit 1 and common components, was employed to evaluate each of the risk benefits and averted costs for each of the SAMAs, and was viewed as also being applicable to Unit 2. That is, if a particular SAMA proves cost beneficial for Unit 1, it will likewise be cost beneficial for Unit 2.

F.6.1 SAMA 1: INSTALL A MINIMUM CCW COOLING FLOW LINE AROUND THE RHR HEAT EXCHANGER OUTLET VALVE

For scenarios in which an SI signal is generated while the RCS pressure remains above the RHR low pressure interlock for extended times, it is necessary for the operators to check the status of the RHR pumps at some point after initiation and to shut them down to prevent pump damage. If CCW is flowing to the RHR heat exchangers, however, the action to trip the RHR pumps is not required to prevent pump failure. A means of preventing RHR pump failure without adding a large, early demand on the CCW system is to add a small, normally open bypass line around the RHR heat exchanger outlet valves in the CCW flowpath. This will allow CCW to remove enough heat from the RHR process fluid to prevent pump damage.

Change Description:

To credit an already open line with a valve on it to serve as a bypass the most optimistic HEP will be used (6.5E-03) in all cases of fires. Apply ZHTRP3 for all cases. Place new top event rules above existing top event rules in FLTREE at positions 3. This only affects fires.

Model Change(s):

In event tree FLTREE: Place new top event rules above existing top event rules in FLTREE at positions 3. This only affects fires.

ZHTRP3 1 (use in all cases).

Event Tree(s): FLTREE

Results of SAMA Quantification:

The following table summarizes the changes to the internal events CDF, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	CDF	**Dose-Risk**	**OECR**
Base Value	8.64E-05	98.89	$246,912
SAMA Value	7.76E-05	96.12	$230,625
Percent Change	10.1%	2.8%	6.6%

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

Release Category	**ST1**	**ST2**	**ST3**	**ST4**	**ST5**	**ST6**	**Total**
$Frequency_{BASE}$	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	1.79E-06	**8.52E-05**
$Frequency_{SAMA}$	7.23E-06	5.58E-06	5.71E-05	1.60E-06	2.77E-06	1.60E-06	**7.65E-05**
$Dose\text{-}Risk_{BASE}$	71.20	6.46	1.60	1.38	18.24	0.01	**98.89**
$Dose\text{-}Risk_{SAMA}$	71.07	5.35	1.42	1.23	17.04	0.01	**96.12**
$OECR_{BASE}$	$88,372	$48,941	$751	$9,774	$99,072	$2	**$246,912**
$OECR_{SAMA}$	$88,206	$40,511	$668	$8,720	$92,518	$2	**$230,625**

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

SAMA 1 Averted Cost-Risk

Unit	Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
DCPP Unit 1	$9,315,791	$8,731,564	$584,227

Based on a $3,020,424 cost of implementation for DCPP, the net value for this SAMA is -$2,436,197 ($584,227 - $3,020,424), which indicates this SAMA is not cost-beneficial.

F.6.2 SAMA 3: CHANGE PROCEDURES TO EXPLICITLY ADDRESS VULNERABILITY OF AUTO SI

The DCPP fire procedure already identifies equipment that may be damaged for each fire area and provides guidance to mitigate failed equipment. A potential enhancement would be explicitly identify that fire damage may impact auto SI actuation and direct the operators to monitor valid instruments to ensure it functions when it is required.

Change Description:

Assume procedure change improves the degraded split fraction (i.e., OSZ1) to that of the instrumentation available (i.e., OSZ2). For cases where Top Event OS is guaranteed failed (i.e., OSZ=F), do not make any changes since this is where the fire is failing the manual action either due to location of the fire, loss of equipment or indication needed to diagnose the event.

Model Change(s):

In MFF BDDAV change the value of OSZ1 from 5.30E-02 to 2.3E-03.

Event Tree(s): MECHSUP

Results of SAMA Quantification:

The following table summarizes the changes to the internal events CDF, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	CDF	Dose-Risk	OECR
Base Value	8.64E-05	98.89	$246,912
SAMA Value	8.16E-05	86.25	$226,380

Percent Change	5.6%	12.8%	8.3%

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

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	Total
$Frequency_{BASE}$	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	1.79E-06	**8.52E-05**
$Frequency_{SAMA}$	6.06E-06	6.32E-06	6.13E-05	1.71E-06	2.89E-06	1.71E-06	**8.05E-05**
$Dose\text{-}Risk_{BASE}$	71.20	6.46	1.60	1.38	18.24	0.01	**98.89**
$Dose\text{-}Risk_{SAMA}$	59.57	6.06	1.53	1.31	17.77	0.01	**86.25**
$OECR_{BASE}$	$88,372	$48,941	$751	$9,774	$99,072	$2	**$246,912**
$OECR_{SAMA}$	$73,932	$45,883	$717	$9,320	$96,526	$2	**$226,380**

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

SAMA 3 Averted Cost-Risk			
Unit	**Base Case Cost-Risk**	**Revised Cost-Risk**	**Averted Cost-Risk**
DCPP Unit 1	$9,315,791	$8,470,504	$845,287

Based on a $376,342 cost of implementation for DCPP, the net value for this SAMA is $468,945 ($845,287 - $376,342), which indicates this SAMA is potentially cost beneficial.

F.6.3 SAMA 5: BACKUP AIR SYSTEM FOR PORV PCV 474

Currently, loss of offsite power or a fire event could results in the loss of the Instrument Air (IA) system. Changing the air supply to PCV 474 (Pressurizer PORV) to a class I backup air supply would prevent this and reduce the loss of IA contributions to core damage.

Change Description:

One way to credit instrument air for PORV 474 is by removing the PORV 474 dependency on the IA system. In other words in event tree GENTRN remove IA=F from all the rules for OB, which includes split fraction OB1, 2, 3 5, 7, 8 and fire split fractions OB1Z1, 2 and 3.

Model Change(s):

Remove "IA=F" from OB split fraction rules in event tree GENTRN. These include split fractions: OB1, 2, 3, 5, 7, 8 and fire split fractions OB1Z1, 2 and 3.

Event Tree(s): GENTRN

Results of SAMA Quantification:

The following table summarizes the changes to the internal events CDF, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	CDF	Dose-Risk	OECR
Base Value	8.64E-05	98.89	$246,912
SAMA Value	8.58E-05	98.76	$246,282
Percent Change	0.7%	0.1%	0.3%

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

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	Total
Frequency_{BASE}	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	1.79E-06	**8.52E-05**
Frequency_{SAMA}	7.24E-06	6.70E-06	6.37E-05	1.78E-06	2.96E-06	1.78E-06	**8.46E-05**
Dose-Risk_{BASE}	71.20	6.46	1.60	1.38	18.24	0.01	**98.89**
Dose-Risk_{SAMA}	71.17	6.43	1.59	1.37	18.20	0.01	**98.76**
OECR_{BASE}	$88,372	$48,941	$751	$9,774	$99,072	$2	**$246,912**
OECR_{SAMA}	$88,328	$48,642	$745	$9,701	$98,864	$2	**$246,282**

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

SAMA 5 Averted Cost-Risk			
Unit	**Base Case Cost-Risk**	**Revised Cost-Risk**	**Averted Cost-Risk**
DCPP Unit 1	$9,315,791	$9,284,572	$31,219

Based on a $3,133,404 cost of implementation for DCPP, the net value for this SAMA is -$3,102,185 ($31,219 - $3,133,404), which indicates this SAMA is not cost-beneficial.

F.6.4 SAMA 8: PROTECT RHR CABLES IN FIRE AREAS 6-A-2 AND 6-A-3

For fires in areas 6-A-2 and 6-A-3, fire induced failure of the 8700A/B and the FCV-641A/B valves lead to loss of the RHR system, which is critical for mitigating the fire scenarios. Providing additional protection for the cables associated with these components in these areas could help improve the likelihood that RHR would remain available.

Change Description:

For areas 6-A-2 and 6-A-3 there are 13 and 14 fire initiators respectively. Out of these 6-A-2 and 6-A-3 fire initiators, the following impact the RHR pump trains:

Fire Area 6-A-2: Z6A2TS1F1, Z6A2TS2F1, Z6A2Bin5F0, ZIY12F1, ZBTC12F1, ZBTC121F1, ZSD12MF1, ZSD12NF1, ZSD12SF1,

Fire Area 6-A-3: ZBTC131F2, ZBTC131F3, ZBTC132F2, ZIY13F1, ZiY14F1, Z6A3TS1BF1, Z6A3TS1AF1, Z6A3TS2F1, ZSD13SF1, ZSD13MF1, and ZSD13NF1

RHR is modeled for fire initiators in top events ZLA, ZLB, VA and VB. With this SAMA, impacts of a fire in Fire Areas 6-A-2 and 6-A-3 on the RHR trains are removed; that is the RHR trains are not fire damaged with implementation of this SAMA.

In the FLTREE split fractions ZLA13 and ZLA7 (which are 1.0) are assigned for Z6A2* initiators for train A. For train B split fractions ZLB13 and ZLB6 (1.0) are assigned for Z6A3* initiators. Top events ZRCA and ZRCB model sump recirc cooling and need to be protected to ensure success of RHR for fires. These initiators need to be removed to simulate protecting the RHR cables in these specific areas.

Model Change(s):

- In FLTREE
  - Remove 6-A-2 fire initiators listed above from the split fraction rules for Top Event ZLA (affected split fraction rules # 38, 39, 42, 60)
  - Remove 6-A-3 fire initiators listed above from the split fraction rules for Top Event ZLB (affected split fraction rules # 98, 122, 123)
- In LATETREE
  - Remove 6-A-2 fire initiators listed above from the split fraction rules for Top Event VA (affected split fraction rule #134)
  - Remove 6-A-3 fire initiators listed above from the split fraction rules for Top Even VB (affected split fraction rule #163)

Results of SAMA Quantification:

The following table summarizes the changes to the internal events CDF, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	CDF	Dose-Risk	OECR
Base Value	8.64E-05	98.89	$246,912
SAMA Value	7.76E-05	96.12	$230,625
Percent Change	10.1%	2.8%	6.6%

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

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	Total
Frequency_{BASE}	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	1.79E-06	**8.52E-05**
Frequency_{SAMA}	7.23E-06	5.58E-06	5.71E-05	1.60E-06	2.77E-06	1.60E-06	**7.65E-05**
Dose-Risk_{BASE}	71.20	6.46	1.60	1.38	18.24	0.01	**98.89**
Dose-Risk_{SAMA}	71.07	5.35	1.42	1.23	17.04	0.01	**96.12**
OECR_{BASE}	$88,372	$48,941	$751	$9,774	$99,072	$2	**$246,912**
OECR_{SAMA}	$88,206	$40,511	$668	$8,720	$92,518	$2	**$230,625**

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

SAMA 8 Averted Cost-Risk

Unit	Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
DCPP Unit 1	$9,315,791	$8,731,564	$584,227

Based on a $1,072,493 cost of implementation for DCPP, the net value for this SAMA is -$488,266 ($584,227 - $1,072,493), which indicates this SAMA is not cost-beneficial.

F.6.5 SAMA 14: PROTECT THE LETDOWN ISOLATION CAPABILITY IN FIRE AREA 5-A-1

In some cases, fires in area 5-A-1 can lead to uncontrolled letdown flow that opens a system relief valves and results in a LOCA path. The DCPP fire procedure already directs actions to isolate the letdown path by depowering the 8149A/B/C valves. To further reduce the risk associated with a letdown LOCA for fires in these areas, a potential enhancement would be to protect the cables associated with either LCV-459 or LCV-460 such that they could function normally and terminate/control flow through the line.

Change Description:

Top Event ZPRL3 models LCV-459 and -460. Several ZPRL3* split fractions are assigned in area 5-A-1, including: ZPRL3A, B, C, and F. Setting each of these to 0.00E+00 would model the success of LCV-459 or LCV-460 to close isolating the uncontrolled letdown event.

Model Change(s):

Set ZPRL3A, B, C, and F to 0.00E+00.

Event Tree(s): FGENPR

Results of SAMA Quantification:

The following table summarizes the changes to the internal events CDF, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	CDF	Dose-Risk	OECR
Base Value	8.64E-05	98.89	$246,912
SAMA Value	8.33E-05	96.40	$240,096
Percent Change	3.6%	2.5%	2.8%

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

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	Total
$Frequency_{BASE}$	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	1.79E-06	**8.52E-05**
$Frequency_{SAMA}$	7.07E-06	6.45E-06	6.19E-05	1.73E-06	2.90E-06	1.73E-06	**8.23E-05**
$Dose\text{-}Risk_{BASE}$	71.20	6.46	1.60	1.38	18.24	0.01	**98.89**
$Dose\text{-}Risk_{SAMA}$	69.50	6.19	1.54	1.33	17.84	0.01	**96.40**
$OECR_{BASE}$	$88,372	$48,941	$751	$9,774	$99,072	$2	**$246,912**
$OECR_{SAMA}$	$86,254	$46,827	$724	$9,429	$96,860	$2	**$240,096**

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

SAMA 14 Averted Cost-Risk			
Unit	**Base Case Cost-Risk**	**Revised Cost-Risk**	**Averted Cost-Risk**
DCPP Unit 1	$9,315,791	$9,046,073	$269,718

Based on a $5,620,896 cost of implementation for DCPP, the net value for this SAMA is -$5,351,178 ($269,718 - $5,620,896), which indicates this SAMA is not cost-beneficial.

F.6.6 SAMA 16: CHANGE PROCEDURES TO CAUTION ABOUT SPURIOUS SI SIGNALS IN SPECIFIC FIRE AREAS

The DCPP fire procedure already includes guidance that addresses spurious actuation of equipment, but its use is not currently tied to specific fire areas. A potential enhancement would be to include cautions in the procedures to identify fire areas where damage could cause specific spurious actuations and identify the attachment with the mitigating steps.

Change Description:

Top event ZPRSI models operators terminating fire-induced spurious SI. If procedures were enhanced operators would be more likely to diagnose spurious SI actuations given that they know where a fire is taking place. Change the ZPRSI split fraction values to 2E-03 (value of HEP ZHEOP1 for terminating SI on SGTR).

Model Change(s):

In MFF change Split fractions for ZPRSI1, 2, 3 to 2E-3.

Event Tree(s): No change to FGENPR

Results of SAMA Quantification:

The following table summarizes the changes to the internal events CDF, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	CDF	**Dose-Risk**	**OECR**
Base Value	8.64E-05	98.89	$246,912
SAMA Value	8.39E-05	96.88	$240,861
Percent Change	2.9%	2.0%	2.5%

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

Release Category	**ST1**	**ST2**	**ST3**	**ST4**	**ST5**	**ST6**	**Total**
$Frequency_{BASE}$	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	1.79E-06	**8.52E-05**
$Frequency_{SAMA}$	7.11E-06	6.38E-06	6.26E-05	1.75E-06	2.92E-06	1.75E-06	**8.30E-05**
$Dose\text{-}Risk_{BASE}$	71.20	6.46	1.60	1.38	18.24	0.01	**98.89**
$Dose\text{-}Risk_{SAMA}$	69.89	6.12	1.56	1.34	17.96	0.01	**96.88**
$OECR_{BASE}$	$88,372	$48,941	$751	$9,774	$99,072	$2	**$246,912**
$OECR_{SAMA}$	$86,742	$46,319	$732	$9,538	$97,528	$2	**$240,861**

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

SAMA 16 Averted Cost-Risk

Unit	Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
DCPP Unit 1	$9,315,791	$9,089,909	$225,882

Based on a $372,788 cost of implementation for DCPP, the net value for this SAMA is -$146,906 ($225,882 - $372,788), which indicates this SAMA is not cost-beneficial.

F.6.7 SAMA 21: CHANGE FIRE PROCEDURES TO INCLUDE FIRE AREA SPECIFIC GUIDANCE ON CONTAINMENT ISOLATION VALVES

The DCPP fire procedure already identifies equipment that may be damaged for each fire area and provides guidance to mitigate failed equipment. A potential enhancement would be to explicitly identify the containment isolation valves that may be impacted for each fire area. Where possible, the fire procedures could direct manual actions to close the valves. In cases where manual isolation would not be desirable until after loss of equipment or core damage, a reference to other procedures, such as the Severe Accident Mitigation Guidelines could be provided.

<u>Change Description:</u>

Improve the human action associated with containment isolation by lowering the split fractions in top events CI, WL, ZOI and CP.

Top Event CP, split fraction CPFIRE: this SF represents the failure to manually isolate the RCP seal water return lines given a fire induced failure of the valves. If there were procedures in addition to instrumentation cues, this split fraction could be reduced by about a factor of 100.

CPFIRE (0.1) reduces to 1E-03

Top Event CI: Split fractions CIA and CIB are assigned for fire and depend on top event ZOI, see below. Since this top event is recovery on top of the operator action in ZOI, each split fraction should be reduced by a factor of 100 to account for the improved procedures.

- CIA (0.1) to 1E-03

- CIB (1.0) to 1E-02

Top Event ZOI: This SF is associated with the operator action to manually perform containment isolation during fires when the instrumentation used for diagnosis is partially degraded or absent. If there were procedures in addition to instrumentation cues, each of these split fractions could be reduced by about a factor of 100:

- ZOI3 to 1E-2
- ZOI5 to 1.9E-3
- ZOI6 to 4.5E-4.

Top Event WL: Split fractions WL1 and WL2 are associated with the operator action to manually open the containment structure sump pump discharge line given no automatic containment isolation signal due to a loss of both SSPS trains. These split fraction values are reduced by a factor of 100.

Model Change(s):

In the MFF change the following split fractions:

- CPFIRE (0.1) to 1E-03
- CIA (0.1) to 1E-03
- CIB (1.0) to 1E-02
- ZOI3 to 1E-2
- ZOI5 to 1.9E-3
- ZOI6 to 4.5E-4
- WLF1 to 1E-3
- WLF2 to 1E-2
- CPM6 to 1E-3
- CPM8 to 1E-3
- CPMF to 1E-3

Event Tree(s): FLTREE, LATETREE, LLOCA

Results of SAMA Quantification:

The following table summarizes the changes to the internal events CDF, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	CDF	Dose-Risk	OECR

Base Value	8.64E-05	98.89	$246,912
SAMA Value	8.66E-05	76.31	$184,204
Percent Change	-0.2%	22.8%	25.4%

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

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	Total
Frequency$_{BASE}$	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	1.79E-06	**8.52E-05**
Frequency$_{SAMA}$	5.47E-06	8.34E-07	7.28E-05	1.84E-06	3.01E-06	1.84E-06	**8.56E-05**
Dose-Risk$_{BASE}$	71.20	6.46	1.60	1.38	18.24	0.01	**98.89**
Dose-Risk$_{SAMA}$	53.77	0.80	1.81	1.41	18.51	0.01	**76.31**
OECR$_{BASE}$	$88,372	$48,941	$751	$9,774	$99,072	$2	**$246,912**
OECR$_{SAMA}$	$66,734	$6,055	$852	$10,028	$100,534	$2	**$184,204**

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

SAMA 21 Averted Cost-Risk

Unit	Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
DCPP Unit 1	$9,315,791	$7,649,658	$1,666,133

Based on a $256,817 cost of implementation for DCPP, the net value for this SAMA is $1,409,316 ($1,666,133 - $256,817), which indicates this SAMA is potentially cost beneficial.

F.6.8 SAMA 23: ENHANCE THE FIREWATER TO CHARGING PUMP COOLING CONNECTION

For cases in which CCW is not available for charging pump cooling, it is possible to connect the Fire Protection system to the charging pump cooling line to provide alternate pump cooling. However, the current alignment requires the use of fire hoses and may not be viable in time stressed events, such as some fire scenarios. By providing a hard piped connection with manual isolation valves, the alignment could be performed rapidly and the reliability of the action could potentially be improved.

Change Description:

Top event ZSEHE models aligning backup cooling to CH. Currently this action is not credited for fires because all the top event split fractions are set to 1.0. There are only 2 split fractions ZSEHEJ and ZSEHEK. By setting these split fractions to 1E-2 hard piped fire water to the CH pumps can be credited for fire scenarios.

Model Change(s):

Top Event ZSEHE: Set ZSEHEJ and ZSEHEK to 1E-2.

Event Tree(s): FGENSI

Results of SAMA Quantification:

The following table summarizes the changes to the internal events CDF, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	CDF	Dose-Risk	OECR
Base Value	8.64E-05	98.89	$246,912
SAMA Value	8.64E-05	98.86	$246,834
Percent Change	0.0%	0.0%	0.0%

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

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	Total
$Frequency_{BASE}$	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	1.79E-06	**8.52E-05**
$Frequency_{SAMA}$	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	1.79E-06	**8.52E-05**
$Dose\text{-}Risk_{BASE}$	71.20	6.46	1.60	1.38	18.24	0.01	**98.89**
$Dose\text{-}Risk_{SAMA}$	71.17	6.46	1.60	1.37	18.24	0.01	**98.86**
$OECR_{BASE}$	$88,372	$48,941	$751	$9,774	$99,072	$2	**$246,912**
$OECR_{SAMA}$	$88,328	$48,932	$751	$9,756	$99,064	$2	**$246,834**

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

SAMA 23 Averted Cost-Risk

Unit	Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
DCPP Unit 1	$9,315,791	$9,313,085	$2,706

Based on a $491,021 cost of implementation for DCPP, the net value for this SAMA is -$488,315 ($2,706 - $491,021), which indicates this SAMA is not cost-beneficial.

F.6.9 SUMMARY

All of the SAMAs reviewed showed at least some benefit with respect to the traditional CDF and LERF risk metrics. Only two (2) of the proposed SAMAs are potentially cost beneficial at the nominal level when comparing the averted cost-risk to the associated implementation costs (SAMAs 3 and 21).

F.7 UNCERTAINTY ANALYSIS

The following three uncertainties were further investigated as to their impact on the overall SAMA evaluation:

- Use a discount rate of 7 percent, instead of 3 percent used in the base case analysis.
- Use the 95th percentile PRA results in place of the mean PRA results.
- Selected MACCS2 input variables.
- Impact of Binning Truncated Frequency to RC ST5

F.7.1 REAL DISCOUNT RATE

The RDR is an estimate of the rate of return on invested dollars above the rate of inflation. A scenario with a low RDR would require a larger investment of present day dollars to pay for a future expense than a scenario with a relatively high RDR. In a SAMA analysis, large RDRs reduce the averted cost-risk values associated with SAMA implementation relative to low RDRs because the present day dollar investment to pay for accident mitigation would be less.

The baseline SAMA analysis uses an RDR of 3 percent, which could be viewed as conservative given that NUREG/BR-0184 suggests the use of an RDR of 7 percent (Reference 21). In this sensitivity case, the Phase 1 and Phase 2 results were re-evaluated using the 7 percent RDR suggested in NUREG/BR-0184.

For the Phase 1 analysis, the MACR was recalculated using the methodology outlined in Section F.4, and the SAMA implementation costs were compared to the revised MACR. Based on the reduction of the MACR to $6,907,382 (a 26 percent reduction of the baseline MACR), no additional SAMAs would be screened in the Phase 1 analysis due to the use of the 7 percent RDR.

For the Phase 2 analysis, the determination of cost effectiveness did not change for any of the Phase 2 SAMAs when the 7 percent RDR was used in lieu of 3 percent, as shown below.

Summary of the Impact of the RDR Value on the Detailed SAMA Analyses

SAMA ID	Cost of Implementation	Averted Cost Risk (3 percent RDR)	Net Value (3 percent RDR)	Averted Cost Risk (7 percent RDR)	Net Value (7 percent RDR)	Change in Cost Effectiveness?
1	$3,020,424	$584,227	-$2,436,197	$442,485	-$2,577,939	No
3	$376,342	$845,287	$468,945	$618,371	$242,029	No
5	$3,133,404	$31,219	-$3,102,185	$24,068	-$3,109,336	No
8	$1,072,493	$584,227	-$488,266	$442,485	-$630,008	No
14	$5,620,896	$269,718	-$5,351,178	$201,632	-$5,419,264	No
16	$372,788	$225,882	-$146,906	$168,571	-$204,217	No
21	$256,817	$1,666,133	$1,409,316	$1,191,876	$935,059	No
23	$491,021	$2,706	-$488,315	$1,975	-$489,046	No

F.7.2 95TH PERCENTILE PRA RESULTS

The results of the SAMA analysis can be impacted by implementing conservative values from the PRA's uncertainty distribution. If the best estimate failure probability values were consistently lower than the "actual" failure probabilities, the PRA model would underestimate plant risk and yield lower than "actual" averted cost-risk values for potential SAMAs. Re-assessing the cost-benefit calculations using the high end of the failure probability distributions is a means of identifying the impact of having consistently underestimated failure probabilities for plant equipment and operator actions included in the PRA model.

A model uncertainty analysis was not performed for DCPP interim model DC03. However, an uncertainty analysis was performed on DCPP model DC02. Since the 95^{th} percentile assessment employs a ratio rather than individual values, a determination was made that it is acceptable to use the DC02 uncertainty results. The basis for this decision is that the 95^{th} to CDF point estimate ratio is not expected to vary significantly between the two models, and hence, should provide a representative value.

In performing the sensitivity analysis, only the base case was used in determining the appropriate value for the 95^{th} percentile. For those SAMAs that required the addition of new basic events, no new uncertainty distributions were assigned since the design and implementation of each SAMA was arbitrary and was defined by the analysis assumptions. The results of this uncertainty analysis, therefore, show the expected statistical uncertainty of the CDF risk metrics under the assumption that each SAMA was designed and implemented as it was specified in this analysis.

All RISKMAN uncertainty calculations were performed as documented in DCPP PRA Calculation C.10 (Reference 43). The results of the uncertainty calculation indicate that the internal events 95th percentile CDF is a factor of 2.67 larger than the point estimate CDF while the internal flooding 95th percentile CDF is a factor of 2.37 larger than the point estimate value. For this sensitivity analysis, the ratio of the internal events 95th percentile CDF to the point estimate CDF has been rounded up from 2.67 to 3.0 in order to estimate the potential impact of parametric model uncertainty on the SAMA analysis.

F.7.2.1 PHASE 1 IMPACT

For Phase 1 screening, use of the 95th percentile PRA results will increase the MACR and may prevent the screening of some of the higher cost modifications. However, the impact on the overall SAMA results due to the retention of the higher cost SAMAs for Phase 2 analysis is typically small. This is due to the fact that the benefit obtained from the implementation of those SAMAs must be extremely large in order to be cost beneficial.

The impact of uncertainty in the PRA results on the Phase 1 SAMA analysis has been examined. The MACR is the primary Phase 1 criteria affected by PRA uncertainty. Thus, this portion of the sensitivity is focused on recalculating the MACR using the 95th percentile PRA results and re-performing the Phase 1 screening process. As discussed above, the 95th PRA results are estimated to be a factor of 3.0 greater than the point estimate CDF.

In order to simulate the use of the 95th percentile PRA results on the cost benefit calculations, the same scaling factor calculated for the Level 1 results was assumed to apply to the Level 3 results. Because the MACR calculations scale linearly with the CDF, dose-risk, and off-site economic cost-risk, the 95th percentile MACR can be calculated by multiplying the base case MACR by 3.0. This results in a 95th percentile MACR of $27,947,373.

The initial SAMA list has been re-examined using the revised MACR to identify SAMAs that would have been retained for the Phase 2 analysis. Those SAMAs that were previously screened due to costs of implementation that exceeded $9.3 million are now retained if the costs of implementation are less than $27,947,373. Of the SAMAs screened in the baseline Phase 1 analysis, SAMAs 2, 6, 7, 9, 10, 12, 17, 20, and 22 would be retained based on the use of the 95th percentile MACR.

For each of these SAMAs, detailed quantifications were performed in order to support a Phase 2 cost benefit analysis, which was not performed as part of the baseline analysis. As shown below, none of the SAMAs produced positive net values. In fact, the net values for each SAMA were significantly negative, providing further justification of screening them from consideration.

F.7.2.1.1 SAMA 2: Provide an Engine Driven SG Makeup Pump

For cases in which the AFW pumps have failed and/or the support systems are failed, such as the 480V AC switchgear, providing an independent means of injecting water to the steam generators could provide the secondary side heat removal function. Ensuring that the makeup pump can be aligned in time to mitigate early loss of AFW scenarios and that diverse pump suction supplies are available (e.g., Fire Water, Raw Water) is required to mitigate the top DCPP risks.

Change Description:

For key split fractions (RRW value greater than 1.001) lower the probability by a factor of 100 to account for an additional makeup pump.

Model Change(s):

In the MFF, lower the probability of the following SFs by a factor of 100: AW4, AWFZ, AWBB, AWBBS, AWBA, AWD AW3A and AWS4.

Event Tree(s): GENTRN, SL

Results of SAMA Quantification:

The following table summarizes the changes to the internal events CDF, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	CDF	Dose-Risk	OECR
Base Value	8.64E-05	98.89	$246,912
SAMA Value	7.80E-05	94.01	$220,740
Percent Change	9.7%	4.9%	10.6%

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

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	Total
$Frequency_{BASE}$	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	1.79E-06	**8.52E-05**
$Frequency_{SAMA}$	7.20E-06	5.98E-06	5.79E-05	1.28E-06	2.45E-06	1.28E-06	**7.69E-05**
$Dose\text{-}Risk_{BASE}$	71.20	6.46	1.60	1.38	18.24	0.01	**98.89**
$Dose\text{-}Risk_{SAMA}$	70.78	5.73	1.44	0.98	15.07	0.01	**94.01**
$OECR_{BASE}$	$88,372	$48,941	$751	$9,774	$99,072	$2	**$246,912**
$OECR_{SAMA}$	$87,840	$43,415	$677	$6,976	$81,830	$2	**$220,740**

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

SAMA 2 Averted Cost-Risk			
Unit	**Base Case Cost-Risk**	**Revised Cost-Risk**	**Averted Cost-Risk**
DCPP Unit 1	$9,315,791	$8,522,944	$792,847

Based on a $17,492,616 cost of implementation for DCPP, the net value for this SAMA is -$16,699,769 ($792,847 - $17,492,616). When the 95th percentile PRA results are used, the averted cost-risk is increased by a factor of 3.0 to $2,378,541, which still yields a negative net value ($2,378,541 - $17,492,616 = -$15,114,075). This SAMA is not cost-beneficial.

The cost estimate for this SAMA conservatively only accounts for the capability to take suction from the CST while the full scope of the SAMA includes the capability to align the pumps to diverse sources. If the capability to align the pump to alternate suction sources were accounted for in the cost estimate, the net value would become more negative.

F.7.2.1.2 SAMA 6: Install an Additional Train of 480V Switchgear Room HVAC

Alternate Switchgear Room cooling procedures already exist for DCPP, but the loss of room cooling is still an important issue. While costly, a potential means of reducing the HVAC failure contribution would be to install an independent train of HVAC.

Change Description:

Recovery of 480V AC switchgear HVAC is modeled in top events SVH (in event tree MECHSUP) for internal events and in ZSVHE for fires (in event tree FMECHSUP). The additional train of HVAC could be modeled in these top events in lieu of the human action to mitigate loss of HVAC.

In top event SVH split fraction SVH1 is used for LOOP initiators. Set this to 4E-4 (one train probability SV4 and LOOP). SVH2 for non-LOOP initiators should be set to the one train probability of 1E-04 (SV1 and non-LOOP). SVH1SA, SVH1SB, SVH1SC are based on HEPs dependent on the seismic level.

For fires modeled in event tree FMECHSUP and top event ZSVHE, the split fractions are all HEPs. Changing them to hardware failure models the impact of an extra train but does not account for the fire impact on power dependency. Thus the delta risk will be conservatively higher than actual.

Model Change(s):

In the MFF, set:

- SVH1 (from 1.1E-02) = 4E-04
- SVH2 (from 6.7E-04) = 1.0E-4
- SVH1SA (from 1.1E-2), SVH1SB (from 5.5E-2), SV1SC (from 3.3E-01) reduce by a factor of 10 to simulate the added fragility of an extra train assuming the fragility of an extra train has better failure probability than a human action.

In the FMECHSUP (fire) event tree: Set ZSVHE1 and ZSVHES to 1E-04 for one train.

Event Tree(s): MECHSUP, FMECHSUP

Results of SAMA Quantification:

The following table summarizes the changes to the internal events CDF, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	CDF	Dose-Risk	OECR
Base Value	8.64E-05	98.89	$246,912
SAMA Value	8.30E-05	95.10	$239,662
Percent Change	3.9%	3.8%	2.9%

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

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	Total
$Frequency_{BASE}$	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	1.79E-06	**8.52E-05**
$Frequency_{SAMA}$	6.92E-06	6.65E-06	6.18E-05	1.72E-06	2.90E-06	1.72E-06	**8.20E-05**
$Dose\text{-}Risk_{BASE}$	71.20	6.46	1.60	1.38	18.24	0.01	**98.89**
$Dose\text{-}Risk_{SAMA}$	68.02	6.38	1.54	1.32	17.84	0.01	**95.10**
$OECR_{BASE}$	$88,372	$48,941	$751	$9,774	$99,072	$2	**$246,912**
$OECR_{SAMA}$	$84,424	$48,279	$723	$9,374	$96,860	$2	**$239,662**

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

SAMA 6 Averted Cost-Risk			
Unit	**Base Case Cost-Risk**	**Revised Cost-Risk**	**Averted Cost-Risk**
DCPP Unit 1	$9,315,791	$8,990,687	$325,104

Based on a $9,993,910 cost of implementation for DCPP, the net value for this SAMA is -$9,668,806 ($325,104 - $9,993,910). When the 95th percentile PRA results are used, the averted cost-risk is increased by a factor of 3.0 to $975,312, which still yields a negative net value ($975,312 - $9,993,910 = -$9,018,598). This SAMA is not cost-beneficial.

F.7.2.1.3 SAMA 7: Automate Swap to Recirculation

The operators are well trained on the action to transition the RCS injection systems to recirculation mode, but automating the process will further improve reliability and reduce the contribution of this action to core damage scenarios.

Change Description:

Assume the hardware failure rate is similar to 2 trains of SSPS (see split fraction S12) and is approximately 5.0E-4. The resultant split fraction will then be the sum of sump plug screening probability (see basic events RFBKA1, RFBKA3, and RFBKA4), and failure probability of 2 SSPS trains.

In top event RF there are split fractions developed for internal events, fire and seismic. The cause table for each includes an HEP and sump screen plugging which depends on the initiator. For the cases where the containment spray (CS) is successful, screen plugging is not considered likely. To develop the split fractions screen plugging needs to be added to the split fraction, if applicable, then the SSPS equivalent value added. For MLOCA a separate top is used, RFM, with its split fractions. For some flooding Ies RWST instrumentation is damaged so the auto switchover would also be likely failed as well.

Model Change(s):

In the MFF set:

- RF1, RF1S = 1.7848E-04 + 5E-04 = 6.78E-04,
- RF2 = 5E-4, CS success so no clogging,
- RF3 = 8.0724E-04 +5E-04 = 1.31E-03,
- RF4 = 4.8435E-02 + 5E-04 = 4.89E-02,
- RF1FL = 1.7848E-04 + 5E-04 = 6.78E-04,
- RF2FL = split fraction is not used,
- RF1Z, RF2Z = 1.7848E-04 + 5E-04 = 6.78E-04,
- RF3Z = 5E-04,
- R4Z = GF

Top Event RFM:

- RF3M = 8.0724E-04 + 5E-04 = 1.31E-03,
- RF4M = 4.8435E-02 + 5E-04 = 4.89E-02.

Event Tree(s): LATETREE

Results of SAMA Quantification:

The following table summarizes the changes to the internal events CDF, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	CDF	Dose-Risk	OECR
Base Value	8.64E-05	98.89	$246,912
SAMA Value	8.15E-05	97.25	$237,235
Percent Change	5.7%	1.7%	3.9%

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

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	Total
$Frequency_{BASE}$	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	1.79E-06	**8.52E-05**
$Frequency_{SAMA}$	7.23E-06	5.95E-06	6.04E-05	1.70E-06	2.87E-06	1.70E-06	**8.04E-05**
$Dose\text{-}Risk_{BASE}$	71.20	6.46	1.60	1.38	18.24	0.01	**98.89**
$Dose\text{-}Risk_{SAMA}$	71.07	5.71	1.50	1.31	17.65	0.01	**97.25**
$OECR_{BASE}$	$88,372	$48,941	$751	$9,774	$99,072	$2	**$246,912**
$OECR_{SAMA}$	$88,206	$43,197	$707	$9,265	$95,858	$2	**$237,235**

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

SAMA 7 Averted Cost-Risk

Unit	Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
DCPP Unit 1	$9,315,791	$8,975,903	$339,888

Based on a $10,616,468 cost of implementation for DCPP, the net value for this SAMA is -$10,276,580 ($339,888 - $10,616,468). When the 95th percentile PRA results are used, the averted cost-risk is increased by a factor of 3.0 to $1,019,664, which still yields a negative net value ($1,019,664 - $10,616,468 = -$9,596,804). This SAMA is not cost-beneficial.

F.7.2.1.4 SAMA 9: Install Spray Barriers to Protect the TD AFW Pump and Install a Waterproof MD AFW Pump

For some flooding scenarios, including those in fire areas 14-A and 3-Q-2, the AFW system is damaged by flood water from fire protection system breaks. Providing barriers to protect the TD AFW pump can reduce the likelihood that the pump will be damaged. The MD AFW pumps are susceptible to flood water incursion via ventilation ducts that must remain open to provide adequate room cooling. To protect the MD AFW pumps from these flooding events, it would be necessary to replace the existing equipment with a waterproof pump.

Change Description:

Flooding from fire suppression systems occurs in areas 14-A and 3-Q-2. To simulate protecting the pump, the fire initiators associated with these areas need to be removed from the split fraction logic that fails the pumps. AFW for fires is modeled in the FGENAFW event tree via top events ZMDP2, ZMDP3 and ZTDP. From flooding initiators Y14A* and Y3Q2* split fractions for the auxiliary feedwater top event AW need to be changed. The initiators Y14* and Y3Q2* need to be removed from the rules.

Model Change(s):

Note: Installation of spray barriers over AFW trains related electrical cabinets will not protect them from fires in Fire Areas 3-Q-2 and 14A. However, fire impacts are removed as well, which allows additional credit for the installation. This is a conservative treatment from the cost-risk analysis perspective.

In FGENAFW for 3-Q-2:

- ZMDP2I: (224) remove Z3Q2 from rule,
- ZMDP3G: (284) remove Z3Q2 from rule,

- ZMDP2F: (206) delete specific rule, fire is not failing component,
- ZMDP3: (270) delete specific rule.

For 14-A:

- ZMDP2I, ZMDP2F, ZMDP2K: remove all instances of INIT=Z14A*,
- ZMDP3F, ZMDP3G: remove all instances of INIT=Z14A*,
- ZTDPD: (509) delete specific rule,
- ZTDPA: (510) delete specific rule,
- ZTDPHF: (565) delete specific rule,
- ZTDPHD: (564) delete specific rule.

In GENTRN for 3-Q-2 and 14-A:

- Change the rule for split fractions AW4, AW4FL, AW9, AW9FL, and AWF remove initiators Y3Q2SP1A and Y14ASP1A.

Event Tree(s): FGENAFW, GENTRN

Results of SAMA Quantification:

The following table summarizes the changes to the internal events CDF, Dose-Risk, and Offsite Economic Cost-Risk resulting from the implementation of this SAMA:

	CDF	Dose-Risk	OECR
Base Value	8.64E-05	98.89	$246,912
SAMA Value	8.51E-05	98.53	$245,402
Percent Change	1.5%	0.4%	0.6%

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

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	Total
Frequency_{BASE}	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	1.79E-06	**8.52E-05**
Frequency_{SAMA}	7.23E-06	6.65E-06	6.31E-05	1.77E-06	2.95E-06	1.77E-06	**8.39E-05**
Dose-Risk_{BASE}	71.20	6.46	1.60	1.38	18.24	0.01	**98.89**
Dose-Risk_{SAMA}	71.07	6.38	1.57	1.36	18.14	0.01	**98.53**
OECR_{BASE}	$88,372	$48,941	$751	$9,774	$99,072	$2	**$246,912**
OECR_{SAMA}	$88,206	$48,279	$738	$9,647	$98,530	$2	**$245,402**

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

SAMA 9 Averted Cost-Risk			
Unit	Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
DCPP Unit 1	$9,315,791	$9,244,114	$71,677

Based on a $25,520,160 cost of implementation for DCPP, the net value for this SAMA is -$25,448,483 ($71,677 - $25,520,160). When the 95th percentile PRA results are used, the averted cost-risk is increased by a factor of 3.0 to $215,031, which still yields a negative net value ($215,031 - $25,520,160 = -$25,305,129). This SAMA is not cost-beneficial.

F.7.2.1.5 SAMA 10: Alternate DC Generator

In order to mitigate DC system failures, an alternate DC generator could be used to directly power a bus (bypasses charger faults) or directly power critical loads (bypasses distribution failures). The generator should be stored in a seismically qualified area so that it would potentially be available to respond in seismic scenarios.

Change Description:

The seismic pretree SEISPRE models the fragility of the DC system. When top event SDC fails electric power event tree ELECPWR DC top events D2F, D2G and D2H are failed. A seismically qualified DC generator that could be used to power loads requiring DC power. A way to model that is to not fail one of the DC buses due to seismic initiators and to decrease the failure probability due to the additional redundant components.

To account for the impact on DC in the long term all the split fractions for top event DF is reduced in probability by a factor of 100.

Assume fire damage to 125V DC bus F prevents the use of the alternate DC equipment.