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PG&E Letter DCL-15-080

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Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Diablo Canyon Power Plant License Renewal Severe Accident Mitigation Alternatives Analysis Evaluation of the 2015 Seismic Hazard Results

Dear Commissioners and Staff:

By Pacific Gas and Electric Company (PG&E) Letter DCL-09-079, "License Renewal Application," dated November 23, 2009, PG&E submitted an application to the U.S. Nuclear Regulatory Commission (NRC) for the renewal of Facility Operating Licenses DPR-80 and DPR-82, for Diablo Canyon Power Plant (DCPP) Units 1 and 2, respectively. The application included the License Renewal Application (LRA) and LRA Appendix E, "Applicant's Environmental Report – Operating License Renewal Stage."

By PG&E Letter DCL-15-027, "Update to the Diablo Canyon Power Plant License Renewal Application (LRA), Amendment 49 and LRA Appendix E, 'Applicant's Environmental Report – Operating License Renewal Stage, Amendment 2'" dated February 25, 2015, PG&E provided updates to LRA Appendix E, Chapter 7, "Alternatives to the Proposed Action," Chapter 8, "Comparison of Environmental Impacts of License Renewal With the Alternatives," Section 9.2, "Alternatives," and Attachment F, "Severe Accident Mitigation Alternatives" (SAMA). PG&E also committed to complete an evaluation of the 2015 seismic hazard results on the SAMA analysis by June 2015.

PG&E Letter DCL-15-035, "Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Seismic Aspects of Recommendation 2.1 of the Near-Term Task force Review of Insights from the Fukushima Dai-ichi Accident: Seismic Hazard and Screening Report," dated March 11, 2015, provided the NRC with an update of the DCPP seismic hazard.

The Enclosure provides an evaluation of the March 2015 DCPP seismic hazard update on LRA, Appendix E, Attachment F that was submitted in February 2015. The evaluation concluded that while the use of the updated seismic hazard probabilistic risk assessment model does have a small impact on the maximum averted cost-risk and the averted cost-risk results, it does not change the conclusions of the SAMA analysis. During the evaluation, PG&E also identified corrections to SAMAs 2, 8, 9, 10, 12, and 17. This evaluation updates the licensing basis for the LRA, Appendix E, Attachment F, SAMA Analysis.

PG&E makes no regulatory commitments (as defined by NEI 99-04) in this letter. This letter includes no revisions to existing regulatory commitments.

If you have any questions regarding this submittal, please contact Mr. Terence L. Grebel, License Renewal Project Manager, at (805) 458-0534.

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

Executed on July 1, 2015.

Sincerely,

Barry S. Allen
Vice President, Nuclear Services

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Evaluation of the March 2010 Seismic Hazard Update on the February 2015 Severe Accident Mitigation Alternatives Analysis

Introduction

Pacific Gas and Electric Company (PG&E) Letter DCL-15-027, "Update to the Diablo Canyon Power Plant License Renewal Application (LRA), Amendment 49, and LRA Appendix E. 'Applicant's Environmental Report- Operating License Renewal Stage.'" Amendment 2, dated February 25, 2015, provided an update to the Diablo Canyon Power Plant (DCPP) Severe Accident Mitigation Alternatives (SAMA) analysis using the 2014 DCPP Probabilistic Risk Assessment (PRA) model (i.e., DC03 model), which is also referred to as the February 2015 SAMA Update.

PG&E Letter DCL-15-035, "Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Seismic Aspects of Recommendation 2.1 of the Near-Term Task force Review of Insights from the Fukushima Dai-ichi Accident: Seismic Hazard and Screening Report," dated March 11, 2015, provided the NRC with an update of the DCPP seismic hazard. These changes have been incorporated into the DCPP PRA model in order to evaluate the impact of the updated seismic hazard information on the DCPP SAMA analysis. The resulting PRA model is identified as the DC03SA model. The DC03SA model uses the same fragilities as the DC03 model. The Long Term Seismic Program (LTSP) fragility curves are acceptable for use in DC03SA because no scaling is necessary for use with the updated hazard spectral information from the March 2015 50.54(f) response. The LTSP uniform hazard spectrum has the same shape (plus or minus 14 percent) in the frequency range of interest (3-8.5Hz) for the 1E-04 hazard level and there are no components in the PRA model in the 1-3Hz range. Above 8.5Hz, use of the LTSP fragility curves leads to a conservative estimate of the core damage frequency because the new ground motions are not as rich in high-frequency content as the LTSP spectra. At other hazard levels relevant to the PRA model (1E-03 to 1E-05); the shape does not differ significantly from the shape at the 1E-04 hazard level.

As shown in the Table 1 below, the initiating event frequencies for all but one of the seismic hazard intervals are smaller for the DC03SA model than for the DC03 model. The exception is that for events with g levels greater than 4.0, the DC03SA model frequency, though still very low, is almost twice as large as the DC03 frequency, as shown in Table 1.

A comparison of the baseline DC03 and DC03SA PRA results are documented in Tables 2a and 2b. Table 2a provides the core damage frequency (CDF) (internal events, seismic, fire, and internal flooding), the corresponding dose-risk and offsite economic cost-risk (OECR) for each model, and the percent change from the DC03 model. Table 2b provides a further breakdown of the dose-risk and OECR information according to release category. The percent change in the release category frequency is

also provided in Table 2b, which is proportional to the change to the dose-risk and OECR (with minor deviations due to rounding).

While the CDF is smaller for DC03SA than for DC03, the "bypass" frequency (ST5) is larger for DC03SA due to the increased severe seismic event frequency (events with g levels greater than 4.0).

In order to assess the impact of the updated seismic hazard information on the DCPP SAMA analysis, the SAMA analysis was reperformed using the DC03SA PRA model. The results of this process are summarized below.

Recalculation of the Non-Fire/Non-Seismic External Events Multiplier

Based on the updates to the seismic initiating event frequencies, the CDF and release category frequencies for DC03SA have changed; however, as shown below, the non-fire/non-seismic external events (EE) multiplier is unchanged from the value of 1.03 reported in the February 2015 SAMA Update. The multiplier was recalculated using the same process described in the February 2015 SAMA Update, Section F.4.6.2. Table 3 reproduces the non-fire/non-seismic external event CDFs that are used in this calculation:

The EE multiplier is calculated as follows (using the internal events, internal flooding, fire, and seismic events CDF of 8.47E-05 from the DC03SA model):

EE Multiplier = (8.47E-05+2.56E-06) / (8.47E-05) = 1.03

Recalculation of the Maximum Averted Cost-Risk (MACR)

Using the updated EE multiplier of 1.03 and the DC03SA PRA model results (internal events, seismic, fire, and internal flooding), the updated MACR is $9,640,262:

MACR = DC03SA Cost Risk * EE Multiplier
MACR = $9,359,478 * 1.03 = $9,640,262

Importance Review Threshold Determination

For the February 2015 SAMA Update, the Level 1 and Level 2 Risk Reduction Worth (RRW) importance lists were reviewed to the 1.01 threshold, as described in the February 2015 SAMA Update, Sections F.5.1.1 and F.5.1.2. When the impacts of the EE were considered, this was determined to correspond to an event that would reduce the cost-risk by $92,200 if it were made completely reliable (reported in the February 2015 SAMA Update as "about $100,000"). For the DC03SA model, the 1.01 RRW review threshold corresponds to a slightly larger dollar value of about $95,500 due to the changes in the CDF and Level 2 release category frequencies. The implication is that, while the split fractions at the end of the DC03SA importance list would correlate to

a slightly larger potential averted cost-risk, the cost-risk is still below $100,000 and the scope of the review meets the requirements of Nuclear Energy Institute (NEI) 05-01 to review the dominant risk contributors. Therefore, the RRW review threshold of 1.01 was retained for this effort.

Importance List Review

Consistent with the review threshold discussion above, the DC03SA Level 1 and Level 2 importance lists were reviewed down to the 1.01 RRW level. The results of the review indicate that the lists consist of essentially the same contributors, but in a different order. The result was that the DC03SA SAMA identification process produced nearly identical results to those documented in the February 2015 SAMA Update. A small number of new split fractions were included in the importance lists; however, the review of these split fractions did not result in the identification of any new SAMAs. Tables 4, 5, and 6 provide the results of the updated importance list reviews.

Phase I Re-Evaluation

The use of the DC03SA model resulted in an increase in the MACR from $9,315,791 to $9,640,262. Because the implementation cost of SAMA 17 is $9,610,440, this change precludes the screening of SAMA 17 in Phase 1. For the DC03SA model, SAMA 17 is retained for evaluation in the baseline Phase 2 analysis.

Phase II Re-Evaluation

For most cases, no changes were made to the February 2015 SAMA Update quantification strategies; however, further review of the results led to the determination that the benefit of one SAMA had been conservatively overestimated. In the February 2015 SAMA Update, the residual heat removal (RHR) cable wrap for SAMA 8 was assumed to 1) prevent damage to critical equipment in which fires were initiated, and 2) to prevent damage to non-RHR components, thereby overestimating the risk reduction associated with wrapping the cables associated with RHR system components in the fire area. For the DC03SA revision, changes were made to the SAMA 8 quantification strategy to remove these assumptions. A description of the updated quantification strategy and results are provided below.

For SAMA 17, the formula used to round the ST4 release category frequency to the number of digits displayed in the calculation was found to erroneously have reduced the frequency to zero, thereby artificially increasing the risk reduction for SAMA 17. This error was corrected and the DC03 results included in this document have also been updated to reflect this correction.

In addition, a comparison of the DC03 and DC03SA averted cost risk-results showed significant deviations for some SAMAs that were unrelated to the changes in the seismic hazard curves. An assessment of the differences identified that for the

February 2015 SAMA Update, a RISKMAN software quantification option related to the treatment of initiating event frequencies was applied in SAMAs 2, 9, and 12 that was not used to quantify the other SAMA cases. SAMA 10 is also impacted because the SAMA 12 results are used for the SAMA 10 quantification. For the DC03SA assessment, this quantification option was changed for SAMAs 2, 9, 12, and by extension 10 to be consistent with the preferred process used for the remainder of the SAMAs. The differences in the DC03 and DC03SA averted cost-risk results documented below for SAMAs 2, 9, 10, and 12 are attributable to both the update of the seismic hazard information and the change made to this quantification option.

SAMA 8 Modeling Update

Fires in the 6-A-2 and 6-A-3 Fire Areas result in the loss of the division direct current (dc) power associated with the RHR cables targeted by SAMA 8 (as well as some additional components). Without the implementation of further measures to protect this equipment from being damaged by the initiating fire, other critical 125 Vdc equipment would be damaged by the fire and RHR would remain unavailable. In addition, some fire initiators, such as those associated with the 125 Vdc distribution panels, fail critical components as part of the initiating fire, and no protective measures can be credited to preserve the associated 125 Vdc division. No credit is taken for SAMA 8 in those scenarios. The following is an updated description of the SAMA 8 quantification strategy.

Change Description

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 and the support systems in these areas could help improve the likelihood that RHR would remain available.

The approach to modeling the protection of the RHR train and support systems in RISKMAN is to remove the fire induced failures related to the relevant equipment trains from the model rules. For fire sequences, the fire initiators are listed in the rule for the RHR/support system split fractions to assign the "guaranteed failure" split fraction when the related components are failed by fire damage. In order to credit a split fraction for certain fire areas, it is necessary to remove the relevant fire initiators from the rule that assigns the "guaranteed failure" split fraction.

The RHR system and power related support system split fractions were reviewed to identify the split fractions that are candidates for modification. RHR is modeled in top events LA and LB for internal events, and ZLA and ZLB for fire initiators. Support for RHR is modeled in dc power top events D2G, D2H, and fire top events ZDF3; ZDG1, 2, 3; and ZDH1, 2 3.

To identify the relevant fire initiating events, the fire model was reviewed for Fire Areas 6-A-2 and 6-A-3. For Fire Areas 6-A-2 and 6-A-3, there are 13 and 14 fire initiators respectively:

Fire Area 6-A-2: Z6A2TS1F1, Z6A2TS2F1, Z6A2BIN5F0, ZIY12F1, ZBTC12F1, ZBTC121F1, ZSD12MF1, ZSD12NF1, and ZSD12SF1.

Fire Area 6-A-3: ZBTC131F2, ZBTC131F3, ZBTC132F2, ZIY13F1, ZIY14F1, Z6A3TS1BF1, Z6A3TS1AF1, Z6A3TS2F1, ZSD13SF1, ZSD13MF1, and ZSD13NF1.

These fire initiators were further reviewed to determine which events could potentially be mitigated by SAMA 8. No credit was taken for SAMA 8 for fires initiated in critical components. For example, for an initiating fire in the 125 Vdc distribution panel, the 125 Vdc division was assumed to be failed and unavailable to support RHR. For fires not initiated in critical components, it was assumed that SAMA 8 could protect all required components (this is a conservative assumption in that it increases the benefit estimated for SAMA 8).

Model Changes

To model the protection of RHR and its support systems in RISKMAN, the following changes were made in the event trees:

FLTREE

All fire initiators listed above were removed from top events ZLA and ZLB. In addition, macro M6A2ALLF was deleted.

LATETREE

All fire initiators listed above were removed from top events VA and VB. In addition, macro M6A2ALLF was deleted.

ELECPWR and FELECPWR

Removed the fire initiators listed below for top events D2G, D2H, and for fire top events ZDF3; ZDG1, ZDG2, ZDG3, ZDH1, ZDH2, and ZDH3. In addition, macro M6A2ALLF was deleted.

Fire Area 6-A-2: ZBTC121F1, ZBTC12F2, Z6A2TS2F1, ZIY12F1, and ZBTC12F1A

Fire Area 6-A-3: ZIY14F1, ZBTC131F3, ZIY131, Z6A3TS2F1, and ZBTC131F2.

Results of SAMA Quantification

The updated PRA results for SAMA 8 are presented in Table 7a. A further breakdown of the dose-risk and OECR information is provided in Table 7b according to release category.

This information was used as input to the averted cost-risk calculation. The results of this calculation are provided in Table 8.

The implementation cost of $1,072,493 for SAMA 8 that was developed by PG&E for the February 2015 SAMA Update was based on the protection of RHR cables only. Increasing the scope of SAMA 8 to protect the support systems identified above would significantly increase the implementation cost; however, for this assessment, the original implementation cost of $1,072,493 has conservatively been retained. Using the cost and the $158,914 averted cost-risk from Table 8, the net value for this SAMA is -$913,579 ($158,914 - $1,072,493), which indicates SAMA 8 is not cost-beneficial. When the 95th percentile PRA results are used, the averted cost-risk is increased by a factor of 3.0 to $476,742, which still yields a negative net value ($476,742 - $1,072,493 = -$595,751). SAMA 8 is not cost-beneficial.

Updated Phase 2 Results

Table 9 provides the PRA results of the DC03SA SAMA quantifications. Table 10 provides a comparison of the 95th percentile cost benefit analysis results for both the February 2015 SAMA Update and the DC03SA model. The same multiplier of 3.0 that was used to develop the 95th percentile results for the DC03 model was also applied here to estimate the 95th percentile results for the DC03SA model.

As documented in Table 10, the only difference in the conclusions of the cost benefit analysis is related to SAMA 8. The determination that SAMA 8 is not cost beneficial for the DC03SA assessment and is not related to the changes in the seismic hazard information. SAMA 8 is a fire-specific enhancement that does not play a role in the mitigation of seismic risk. The reduction in the SAMA 8 averted cost-risk in the DC03SA quantification relative to the DC03 quantification is due to changes made to the SAMA 8 modeling. A more detailed review of the fire impacted components identified that the original scope of changes proposed by SAMA 8 would not effectively preserve the RHR function, and that additional measures would be required. In addition, some critical equipment would be damaged by the initiating fires such that no cable wrapping or fire barrier installation would prevent loss of the RHR system.

Finally, the impact of binning the "truncated frequency" to the ST5 release category has been evaluated for the DC03SA model. With the exception that SAMA 8 is not considered to be potentially cost beneficial for the DC03SA SAMA update (as described above), the conclusions of this sensitivity case are the same as those for the February

2015 SAMA Update. Table 11 provides a comparison of the results of this sensitivity case for the DC03SA model and the February 2015 SAMA Update.

In conclusion, while the use of the DC03SA model does have a small impact on the MACR and the averted cost-risk results, it does not change the conclusions of the SAMA analysis.

Table 1: Seismic Initiating Event Frequency Update Summary

Initiating Event	DC03	DC03SA
SEIS1 (g levels 2.0E-1 to 1.25)	1.30E-02	7.23E-03
SEIS2 (g levels 1.25 to 1.75)	3.18E-04	1.51E-04
SEIS3 (g levels 1.75 to 2.00)	5.15E-05	2.68E-05
SEIS4 (g levels 2.00 to 2.50)	4.14E-05	2.50E-05
SEIS5 (g levels 2.5 to 3.00)	1.28E-05	9.20E-06
SEIS6 (g levels 3.00 to 3.99)	6.15E-06	5.57E-06
New (g levels greater than 4.0)	1.16E-06	2.23E-06

Table 2a: DC03/DC03SA Model Results Comparison

	CDF	Dose-Risk	OECR
DC03 Base Value	8.64E-05	98.89	$246,912
DC03SA Base Value	8.47E-05	98.22	$272,281
Percent Change	-2.0%	-0.7%	10.3%

Table 2b: DC03/DC03SA Model Results Comparison by Release Category

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	Total
$Frequency_{DC03}$	7.24E-06	6.74E-06	6.42E-05	1.79E-06	2.97E-06	2.24E-06	**8.52E-05**
$Frequency_{DC03SA}$	6.54E-06	6.69E-06	6.24E-05	1.76E-06	4.00E-06	2.10E-06	8.35E-05
Percent Change	-9.7%	-0.7%	-2.8%	-1.7%	34.7%	-6.3%	-2.0%
$Dose\text{-}Risk_{DC03}$	71.2	6.46	1.6	1.38	18.24	0.01	**98.89**
$Dose\text{-}Risk_{DC03SA}$	64.29	6.42	1.55	1.35	24.60	0.01	98.22
$OECR_{DC03}$	$88,372	$48,941	$751	$9,774	$99,072	$2	**$246,912**
$OECR_{DC03SA}$	$79,788	$48,569	$730	$9,592	$133,600	$2	$272,281

Table 3: Non-Fire/Non-Seismic IPEEE Contributor Summary External Event Initiator Group CDF

High Winds	3.20E-07
Transportation & Nearby Facility – ship impact	1.90E-08
Transportation & Nearby Facility - accidental aircraft impact	7.00E-07
External Flooding	7.20E-07
Chemical Release	8.00E-07
Total EE CDF	**2.56E-06**

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZHTRP2	1.60E-01	1.118	Operator Action - Degraded Instrumentation	This event represents the failure to trip the residual heat removal (RHR) pumps before failure when they have been "deadheaded" without component cooling water (CCW) flow to the RHR heat exchangers (Hx). A potential means of precluding the need for the operators to remember to trip the RHR pumps would be to install a normally open CCW flow bypass line around the RHR Hx outlet valve. This would ensure that minimum cooling flow would be available to prevent damage to the RHR pumps when they are running with the reactor coolant system (RCS) at high pressure (SAMA 1).
AWR1	2.93E-04	1.071	Failure to supply water from fire water storage tank or raw water reservoir (non-seismic)	This event represents the failure to align an alternate water source (e.g., the fire water storage tank) to auxiliary feedwater (AFW) given the unavailability of the condensate storage tank (CST). The top contributors including this (split fraction) SF are cases where service water or CCW have failed and the CST is depleted. The human failure event (HFE) for this action is based on a relatively long process that is assumed to include venting of the initially operating pump. A potential alternate approach to restoring steam generator (SG) makeup would be to provide an engine driven SG makeup pump that can be aligned in time to mitigate loss of SG makeup scenarios. This could simplify alignment in cases where CST rupture may have resulted in air entrainment in the initially operating pump (SAMA 2).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
PRB1A	1.76E-01	1.069	PR Failed due to PORV 455C 8000B Failure - FOR FIRE AREA 1A and 9A	For fires in the containment annular area (91ft and 115ft), the cables for Power-Operated Relief Valve (PORV) 455C are impacted, leading to an induced loss-of-coolant accident (LOCA) scenario. In most of the scenarios including this SF, the failure to trip the RHR pumps while "deadheaded" leads to loss of the containment heat removal function. A potential means of precluding the need to trip the RHR pumps would be to install a normally open CCW flow bypass line around the RHR Hx outlet valve. This would ensure that minimum cooling flow would be available to prevent damage to the RHR pumps when they are running with the RCS at high pressure (SAMA 1).
RECSR	6.50E-02	1.065	Recovery actions for CSR Scenarios from hot shutdown panel (HSP)	This SF represents the failure of recovery actions performed at the hot shutdown panel for cable spreading room fires. The cable spreading room (area 7A) is (or will be) equipped with multiple types of fire detection equipment, including smoke, heat, and incipient smoke detectors. Auto CO_2 suppression is also installed to help reduce the frequency of the fires. Fires in this area can lead to the need to perform a large number of mitigating actions at the remote shutdown panel. The significant sequences that include this SF all include the SF for failure to trip a "deadheaded" RHR pump and an otherwise available low pressure injection/heat removal system is lost. A potential means of precluding the need for the operators to remember to trip the RHR pumps would be to install a normally open CCW flow bypass line around the RHR Hx outlet valve. This would ensure that minimum cooling flow would be available to prevent damage to the RHR pumps when they are running with the RCS at high pressure (SAMA 1).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
OSZ1	5.30E-02	1.065	MANUAL ACTUATION IN EVENT SSPS FAILS: Instrumentation degraded	This event represents the failure to manually initiate safety injection (SI) in fire scenarios in which auto initiation has been failed by the fire and the instrumentation used for action diagnosis has been degraded (at least one train impacted by the fire). The fire procedure already identifies the instruments and equipment that can potentially be impacted for each fire area and directs actions to mitigate those failures. A potential means of improving the response would be to update the fire procedures to explicitly identify that auto SI is vulnerable to failure and to identify the instruments that should be used to check for the need to manually initiate SI (SAMA 3).
ZTDPHD	1.00E-01	1.051	Failure to control SG 2/3 Water Level: Partial Instruments are available	This SF represents failure to control SG level in scenarios where the fire has impacted the SG controls/instrumentation. The fire procedure identifies the fire areas where these degradations may occur and provides viable manual mitigation actions. Most of the top sequences containing this SF also include feed and bleed failures that occur in conjunction with loss of instrument air conditions that fail PORV 474. Providing PORV with an alternate air source that can support long term feed and bleed (F&B) function in these events would potentially improve the reliability of the F&B function (SAMA 5).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
PR6BWZ	9.66E-02	1.043	Fire - 456 available, 8000C and 455C failed. Overlaps with PR9. Water Challenge.	This SF is primarily associated with induced LOCAs for fires in Fire Area 6-A-3. The boundary conditions are failure of the pressure relief top event given failure of PORV 455C and Block Valve 8000C and availability of PORV 456. These scenarios also generally include spurious operation of the pressurizer heaters, which can force a PORV open and lead to a LOCA without the ability to close a block valve (failed by fire). The DCPP fire procedure already directs actions for the relevant fire area to deenergize the pressurizer heaters. In many scenarios, an RHR pump is failed due to the failure to trip the "deadheaded" RHR pumps. A potential means of precluding the need for the operators to remember to trip the RHR pumps would be to install a normally open CCW flow bypass line around the RHR Hx outlet valve. This would ensure that minimum cooling flow would be available to prevent damage to the RHR pumps when they are running with the RCS at high pressure (SAMA 1). In other cases, RHR B is failed because the pump, Suction Valve 8700B, FCV-641B, and or support systems are failed. Fire barriers could be installed to protect equipment "targets" and the cables for RHR could be protected in Fire Areas 6-A-2 (RHR A) and 6-A-3 (RHR B) to address the scenarios for both the A and B RHR trains (SAMA 8).
RF3Z	1.60E-01	1.041	FIRE: SWITCHOVER TO RECIRCULATION AFTER SLOCA DEGRADED INSTRUMENTATION	Automating the swap to recirculation mode could improve the reliability of the function (SAMA 7).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
PR6GWZ	9.66E-02	1.038	Fire - 456 and 8000B failed. 8000C and 455C available. Overlaps with PR1E. Water Challenge.	This SF is primarily associated with induced LOCAs for fires in Fire Area 6-A-2. The boundary conditions are failure of the pressure relief top event given failure of PORV 456 and Block Valve 8000B and availability of 8000C and 455C. These scenarios also generally include spurious operation of the pressurizer heaters, which can force a PORV open and lead to a LOCA without the ability to close a block valve (failed by fire). The DCPP fire procedure already directs actions for the relevant fire area to deenergize the pressurizer heaters. In many scenarios, an RHR pump is failed due to the failure to trip the "deadheaded" RHR pumps. A potential means of precluding the need for the operators to remember to trip the RHR pumps would be to install a normally open CCW flow bypass line around the RHR Hx outlet valve. This would ensure that minimum cooling flow would be available to prevent damage to the RHR pumps when they are running with the RCS at high pressure (SAMA 1). In other cases, RHR B is failed because the pump, Suction Valve 8700B, FCV-641B, and or support systems are failed. Fire barriers could be installed to protect equipment "targets" and the cables for RHR could be protected in Fire Areas 6-A-2 (RHR A) and 6-A-3 (RHR B) to address the scenarios for both the A and B RHR trains (SAMA 8).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
AW4	1.61E-02	1.037	SUPPORT FOR BOTH MOTOR-DRIVEN (MD) PUMPS UNAVAILABLE	Some of the larger contributors to failure of the AFW MD pumps are related to spray damage from fire protection system flooding scenarios (Fire Areas 14A and 3Q2). A potential means of addressing this failure mode would be to provide barriers to protect the turbine-driven (TD) AFW pump from spray damage. For the MD AFW pumps, ventilation ducts that must remain open for AFW room cooling are located in the flood area and protecting the MD AFW pumps requires replacing the pump with one that that can function in the water (SAMA 9). An alternate approach to restoring SG makeup would be to provide an engine driven SG makeup pump that can be aligned in time to mitigate loss of SG makeup scenarios (SAMA 2). Smaller contributors include failures of dc Bus H. In these cases, a portable dc generator could be used to provide control power to a MD AFW pump if 4 kV power is available or to support the TD AFW pump (SAMA 10).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZSVHES	5.80E-03	1.036	480V Switchgear Ventilation - Operator Action: No fire damage to flow switches	This is an operator action that is performed in a fire event to mitigate loss of normal 480 V Switchgear cooling with degraded indication (to support operator action). The existing fire procedures already identify that room cooling for the 480 V switchgear may be impacted by fires in the relevant areas (primarily 14D) and identify that manual action to open the doors/place portable fans for alternate cooling should be performed. This is a relatively simple mitigation method and human dependence issues would limit credit requiring additional operator action. A redundant train of 480 V switchgear room heating, ventilation, and air conditioning could be installed to reduce these contributors (SAMA 6). Alternatively, a portable dc generator could be used to directly power critical loads in the event that loss of room cooling has failed the equipment in the 480 V switchgear area (SAMA 10).
LA1	6.41E-03	1.033	RHR PUMP TRAIN A STARTS AND RUNS FOR 24 HOURS: ALL SUPPORT AVAILABLE (SBLOCA)	This event represents the failure of RHR pump A to start and run for 24 hours. The top contributors are for small LOCAs combined with failure of the B RHR pump train to operate for 24 hours (ultimately, there is no recirculation capability). Installing a swing RHR pump that can be supplied from any power division would provide the capability to pump water through an existing RHR Hx to provide a means of removing heat from containment (SAMA 11).
LP1	6.21E-04	1.032	ALL SUPPORT AVAILABLE (SLOCA)	LP1 is a conditional SF that equates to SF LB2, which is explicitly addressed below.

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
LB2	9.69E-02	1.032	ALL SUPPORT AVAILABLE (LA FAILED - SLOCA)	This event represents the failure of RHR pump B to start and run for 24 hours. The top contributors are for small LOCAs combined with failure of the A RHR pump train to operate for 24 hours (ultimately, there is no recirculation capability). Installing a swing RHR pump that can be supplied from any power division would provide the capability to pump water through an existing RHR Hx to provide a means of removing heat from containment (SAMA 11).
AZAF3	2.70E-02	1.029	UNIT 1 4.16 KV BUS F: HF13/HF14 impacted - Recovery successful	This event represents the fire induced failure of the 4 kV Bus F (but not due to operator error to manually swap from the Auxiliary transformer to the Startup transformer). The top contributors are fires in the 12 kV cable spreading room (Area 1085) and safeguards room (Area 8G), which are combined with other fire induced and random failures that lead to induced station blackouts (SBOs) and cases where only one 4 kV division is available combined with other hardware failures that prevent RCS makeup. Charging remains available but SI and feed and bleed fails due to lack of support or control room ventilation to the solid state protection system is lost due to the fire with failure of operator actions for recovery resulting in failure of SI. This SF often occurs with AWFZ and AZAH7 (ZAH7). For scenarios with charging available, providing an engine driven SG makeup pump could restore secondary side heat removal capability (SAMA 2). For the SBO scenarios, alternate, independent means of both primary and secondary side makeup would be required for long term success, which could be provided by portable, engine driven primary and secondary side makeup pumps (SAMA 18).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
GXH	3.50E-02	1.029	1/3 DIESELS UNAVAILABLE (BUS H)	GXH is an "Intermediate" SF used to calculate GH1 and other conditional SFs associated with failure of diesel generator (DG) 1-1. The top contributors including this event are flooding events in the AFW rooms that include random loss of offsite power. In these scenarios, the condensate feedwater system is unavailable and combined with F&B failure (2/3 PORVs failed: Bus 1H fails PORV 456, and PORV 474 via FCV-584), there are no heat removal options. A potential approach to restoring SG makeup would be to provide an engine driven SG makeup pump that can be aligned in time to mitigate loss of SG makeup scenarios (SAMA 2).
OG1	9.27E-03	1.029	ALL SUPPORT AVAILABLE	This event represents the availability of offsite power to the plant (including parts of the DCPP switchyard). While it is theoretically possible to improve the reliability of the switchyard equipment, it would be difficult to quantify the changes in reliability based on component changes. A more effective means of mitigation is considered to be providing the plant with the capability to survive a long term SBO. In this case, a 480 V alternating current (ac) generator could be used to supply the battery chargers for long term AFW support in conjunction with a self-cooled, 480 Vac RCS high pressure injection pump that can be used to make up for normal seal leakage or boil off if SG makeup fails (SAMA 12).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZPRL3A	4.37E-02	1.028	Normal letdown LOCA due to fire induced/random failures: All components impacted - Recovery of 8149A, B, C impacted. (HEP=1)	This event represents a letdown path LOCA with failure of the recovery action to isolate the LOCA pathway by opening the dc supply breakers for the valves. DCPP currently has fire procedures that direct this action for fires in the relevant area and no additional changes to the procedures have been identified that would significantly improve action reliability. A potential enhancement would be to provide fire barriers to protect the cables related to the valves in the letdown path associated with LOCA (Valves 8149A, B, C, LCV-459, and LCV-460). Ensuring that either LCV-459 or -460 is protected in Area 5A1 could prevent or mitigate the fire induced LOCA (SAMA 14).
AWFZ	5.24E-01	1.028	No support for AFWP2, AFWP3 and fire impacts on AFWP1.	This event represents the failure of AFW given than the fire has impacted TD AFW Pump 1-1 and the unavailability of MD Pumps 1-2 and 1-3 due to support system failure. Since there is a loss of all secondary heat removal the only cooling function that remains is F&B. The top sequences containing this SF are for fire initiators in the Electrical Area (6-A-5) and the Safeguards Room (8G). For fire in Area 6A5 CCW and SI is lost due to the fire. Since CCW is lost, all charging is lost and F&B is unavailable. In order to mitigate these scenarios, alternate, independent means of both primary and secondary side makeup would be required for long term success, which could be provided by portable, engine driven primary and secondary side makeup pumps (SAMA 18). For Area 8G see AFAZ3.

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
GF1	3.50E-02	1.025	DG 1-3 (BUS F) STARTS & RUNS FOR 6 HR	This SF represents the failure of Diesel Generator (DG) 1-3 to start and run for 6 hours. Cross-tie from the opposite unit is available, but common cause failures limit the credit associated with this capability in the model. Installation of a self-contained, independent swing diesel, not dependent on external support systems, would provide increased defense in depth and should be considered for loss of onsite emergency ac power sources (SAMA 15). A potential alternate solution is to use a 480 Vac generator to supply the battery chargers for long term AFW support in conjunction with a self-cooled, 480 Vac RCS high pressure injection pump that can be used to make up for normal seal leakage or boil off if SG makeup fails (SAMA 12).
PRC1A	1.73E-01	1.024	PR Failed due to PORV 456C 8000C Failure - FOR FIRE AREA 1A and 9A	This SF represents the failure of PORV 456 and Block Valve 8000C in a manner that leads to a PORV LOCA. The SF is highly coupled with the SF ZHTRP2, which leads to failure of the remaining RHR pump that could otherwise be used to mitigate the LOCA. In these cases, operating RHR pumps are "deadheaded" and will eventually fail unless the operator trips the pump(s) or initiates flow to the associated RHR Hx from CCW. The procedures are currently set up to direct the operators to trip the pumps at some point after they have initiated if they are not required. A potential means of precluding the need for the operators to remember to trip the RHR pumps would be to install a normally open CCW flow bypass line around the RHR Hx outlet valve. This would ensure that minimum cooling flow would be available to prevent damage to the RHR pumps when they are running with the RCS at high pressure (SAMA 1).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
SIZCR6	8.41E-01	1.023	8974A, and All ZSI1 components impacted	This event is primarily linked to Fire Area 5-A-1 and represents the failure of the SI function when SI to refueling water storage tank (RWST) Recirculation Valve Motor-Operated Valve (MOV) 8974A transfers closed. In all top contributors, SI is required to mitigate a letdown line LOCA. DCPP currently has fire procedures that direct this action for fires in the relevant area and no additional changes to the procedures have been identified that would significantly improve action reliability. A potential enhancement would be to provide fire barriers to protect the cables related to the valves in the letdown path associated with LOCA (valves 8149A, B, C, LCV-459 and LCV-460). Ensuring that either LCV-459 or -460 is protected in Area 5A1 could prevent or mitigate the fire induced LOCA (SAMA 14).
HRF23A	6.00E-01	1.022	Fire - HR Fails due to ZHR23A fails: NO FLOW PATH FROM RHR TO HIGH PRESSURE PUMPS:	This event is primarily linked to Fire Area 5-A-1 and represents the failure of the SI function when either MOV 8923A or B fails closed. In all top contributors, SI is required to mitigate a letdown line LOCA. DCPP currently has fire procedures that direct this action for fires in the relevant area and no additional changes to the procedures have been identified that would significantly improve action reliability. A potential enhancement would be to provide fire barriers to protect the cables related to the valves in the letdown path associated with LOCA (Valves 8149A, B, C, LCV-459, and LCV-460). Ensuring that either LCV-459 or -460 is protected in Area 5A1 could prevent or mitigate the fire induced LOCA (SAMA 14).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZPRSI2	2.80E-01	1.021	Operator action to terminate spurious SI: Degraded instrumentation	This SF represents the failure to terminate a fire induced spurious SI signal. In this case, the fire has degraded the instrumentation used to diagnose the SI termination action. The DCPP fire procedure already includes guidance on addressing spurious actuation of SI and it is directed to be used for any fire scenario. A potential enhancement to consider would be to include a note identifying the spurious signal actuations that may occur in each fire area with a reference to the attachment that governs the mitigating steps for the associated spurious actuation (SAMA 16).
OB1Z2	1.34E-01	1.020	Fire - Loss of Instrument Air (HEP successful) and Instrumentation Degraded	The event represents the failure of the feed and bleed function in cases where there is successful operator action (even with degraded instrumentation), but failure due to hardware based reasons. Providing a backup air supply to PORV PCV 474 could reduce the feed and bleed failures associated with loss of instrument air (SAMA 5).
RF1Z	8.68E-03	1.020	FIRE: SWITCHOVER AFTER SLOCA OR B&F WITH CS FAILED	This SF is related to operator error to perform swap to recirculation mode in fire scenarios. The sequences including the SF typically include induced LOCAs via spurious pressurizer heater actuation or PORV pathways that force bleed and feed operation. Automating the swap to recirculation mode could improve the reliability of the function (SAMA 7).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZTDPHS	5.00E-02	1.019	Failure to control SG 2/3 Water Level: All Instruments are available	This SF is related to operator failure to control SG level, which leads to the need for F&B cooling. In the top contributors, the transition to F&B is failed due to hardware issues. Providing a backup air supply to PORV PCV 474 could reduce the F&B failures associated with loss of instrument air (SAMA 5). In other scenarios, the swap to recirculation mode fails. Automating the swap to recirculation mode could improve the reliability of the function (SAMA 7).
WFLO2N	2.20E-03	1.019	Operator Fails to Isolate Raw Water Reservoir for 6 inch Firewater Flood	This SF is associated with a number of different fire protection flooding scenarios that result in flood damage to the charging and CCW pumps, as well as the RHR pumps. Lack of reactor coolant pump (RCP) seal cooling results in an RCP seal LOCA without high pressure injection capability. In some cases, AFW and condensate/feedwater makeup capability to the SGs is also failed. A potential means of mitigating the event would be to provide water level sensors in critical areas, such as those housing the charging pumps, AFW pumps, CCW pumps, and RHR pumps that could actuate on high level to shut down the fire protection pumps when there is not a coincident fire alarm (SAMA 17). These types of events could also potentially be mitigated through the use of portable, engine driven, high pressure RCS and SG injection pumps (SAMA 18).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
SDS1	2.17E-02	1.019	RCP Shutdown seals Fail to Actuate	This SF represents failure of the shutdown seals to actuate and is primarily important in fire related events. The fires occur in several different areas and result in the loss of seal cooling for a range of different reasons, which makes it impractical to protect component cables to prevent the loss of the seal cooling function. The DCPP fire procedures already identify components that may be impacted on an area by area basis and provide mitigating actions to recover from the failures. These types of events could also potentially be mitigated through the use of portable, engine driven, high pressure RCS and SG injection pumps (SAMA 18).
BB1G	1.97E-02	1.018	UNIT 2 VITAL AC/DC SYSTEM: Train 2G fails with Recovery - TS=S	This SF is an intermediate SF for Unit 2 power failures. These failures show up in the importance list, but are non-minimal failures that do not directly impact the sequence of events. No SAMAs are required.
OR1	2.30E-02	1.017	OPERATOR COOLDOWN AND DEPRESSURIZE RCS	This top contributors associated with this SF are non-isolated SG tube rupture (SGTR) initiating events, which are often combined with failures to isolate the ruptured SG. While the importance of this event may be overestimated due to conservative human reliability analysis (HRA) techniques, some changes could be made to reduce the frequency of the sequences containing this action. Primary side isolation valves would simplify both the action to isolate a ruptured SG, the action to cool down/depressurize the RCS after isolation, and help prevent induced SGTR events (SAMA 19).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZAH7	5.00E-01	1.017	4.16-kV Bus H fails due to fire: HH14 affected - Conditional recovery - Local action	This is an intermediate SF for AZAH7, which represents the fire induced failure of 4 kV Bus H with conditional failure to locally close the 4 kV breaker on Bus H to provide power to the bus from the startup transformer. This generally occurs in conjunction with the SF for failure of the F (AZAF3) bus given the condition that the action to swap to the startup source was not a cause of failure (which also leaves Bus F unavailable) and AWFZ. The top contributors are fires in the safeguards room (Area 8G), which are combined with cases where lack of power combined with other failures prevent RCS makeup for mitigation of induced LOCAs from pressurizer heater actuation. For these scenarios, alternate, independent means of both primary and secondary side makeup would be required for long term success, which could be provided by portable, engine driven primary and secondary side makeup pumps (SAMA 18).
AZAG7	5.00E-01	1.015	HG14 affected - Conditional recovery - Local action	This event represents the fire induced failure of 4 kV Bus G with conditional failure to locally close the 4 kV breaker on Bus G to provide power to the bus from the startup transformer. This generally occurs in conjunction with fires in the 12 kV cable spreading room (Area 1085) that result in SBO conditions due to fire induced failures that also leave the F and H Buses unavailable. A potential solution is to use a 480 Vac generator to supply the battery chargers for long term AFW support in conjunction with a self-cooled 480 Vac RCS high pressure injection pump that can be used to make up for normal seal leakage or boil off if SG makeup fails (SAMA 12).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
SACSS5	1.69E-01	1.015	SEISMIC FAILURE OF AC TB STRUCT SUCCESSFULE: SEIS5, Hazard Levels: 2.500E+00 to 3.00E+00	This SF represents the failure of all vital 4 kVac power given that the turbine building strut does not fail due to the seismic event. In most cases, the 230 kV offsite supply is also failed and power is not available to the site at all. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).
SVZ3R1	2.73E-02	1.014	480 V SWITCHGEAR VENTILATION: E-43, S-43 and HD43-SO impacted - run failure	This SF represents the failure of the 480 V switchgear ventilation function given that a fire has failed one of the two redundant trains. The SF is generally paired with failure of the operator action to open the doors for alternate ventilation, which is an action that is clearly directed in the current DCPP fire procedure for the relevant fire area (instrumentation is available to support the action). Failure of 480 V switchgear ventilation eventually results in loss of all 3 divisions of safety-related 480 Vac power and all three safety-related dc divisions after battery depletion. Because the 480 V switchgear and battery chargers are failed, mitigating equipment will be required to operate without 480 Vac and 125/250 Vdc support. A redundant train of 480 V switchgear room HVAC could be installed to reduce these contributors (SAMA 6). Alternatively, these types of events could potentially be mitigated through the use of portable, engine driven, high pressure RCS and SG injection pumps (SAMA 18).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
AZAH7	5.00E-01	1.014	HH14 affected - Conditional Recovery - Local action	This SF represents the fire induced failure of 4 kV Bus H with conditional failure to locally close the 4 kV breaker on Bus H to provide power to the bus from the startup transformer. This generally occurs in conjunction with the SF for failure of the F (AZAF3) Bus given the condition that the action to swap to the startup source was not a cause of failure (which also leaves Bus F unavailable) and AWFZ. The top contributors are fires in the safeguards room (Area 8G), which are combined with cases where lack of power combined with other failures prevent RCS makeup for mitigation of induced LOCAs from pressurizer heater actuation. For these scenarios, alternate independent means of both primary and secondary side makeup would be required for long term success, which could be provided by portable, engine driven, primary and secondary side makeup pumps (SAMA 18).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZPRIS2	1.50E-01	1.014	Instrumentation degraded	This SF represents the failure to isolate a spuriously opened PORV with degraded instrumentation. There are several contributing fire areas and different combinations of injection/heat removal failure that lead to core damage; however, one of the larger contributors is the loss of RHR due to the failure to trip "deadheaded" RHR pumps. A potential means of precluding the need for the operators to remember to trip the RHR pumps would be to install a normally open CCW flow bypass line around the RHR Hx outlet valve. This would ensure that minimum cooling flow would be available to prevent damage to the RHR pumps when they are running with the RCS at high pressure (SAMA 1). The current DCPP fire procedure already identifies actions to close spuriously operating PORVs from the hot shutdown panel and to trip the pressurizer heaters in the scenarios where they can be impacted, which would prevent the induced PORV LOCAs.
GXF	3.50E-02	1.013	1/3 DIESELS UNAVAILABLE (BUS F)	This is an intermediate SF for GF1 related to the failure of DG 1-3 to start and run for 6 hours. Cross-tie from the opposite unit is available, but common cause failures limit the credit associated with this capability in the model. Installation of a self-contained, independent swing diesel, not dependent on external support systems, would provide increased defense in depth and should be considered for loss of onsite emergency ac power sources (SAMA 15). A potential alternate solution is to use a 480 Vac generator to supply the battery chargers for long term AFW support in conjunction with a self-cooled, 480 Vac RCS high pressure injection pump that can be used to make up for normal seal leakage or boil off if SG makeup fails (SAMA 12).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZHTRP3	6.50E-03	1.012	Operator Action - Instrumentation OK	This event represents the failure to trip the RHR pumps before failure when they have been "deadheaded" without CCW flow to the RHR Hxs. A potential means of precluding the need for the operators to remember to trip the RHR pumps would be to install a normally open CCW flow bypass line around the RHR Hx outlet valve. This would ensure that minimum cooling flow would be available to prevent damage to the RHR pumps when they are running with the RCS at high pressure (SAMA 1).
PR6AW1	9.66E-02	1.012	PRESSURE RELIEF: Fire - 8000C, 456 available, 455C failed. This will overlap with split fraction PRM. Water Challenge. Block valve closure fails.	This SF is primarily associated with induced LOCAs for fires in Fire Area 6-A-1. The SF boundary conditions indicate that Block Valve 8000C and PORV-456 are available while PORV-455C is failed. The fire procedure indicates that for fires in this area, Block Valve 8000A and the PZR heaters may be impacted. These scenarios generally include spurious operation of the pressurizer heaters and induced LOCAs. Core damage results either because the action to swap to recirculation fails, or because an RHR pump has been damaged due to the failure to trip after prolonged "deadheaded" operation. A potential means of precluding the need for the operators to remember to trip the RHR pumps would be to install a normally open CCW flow bypass line around the RHR Hx outlet valve. This would ensure that minimum cooling flow would be available to prevent damage to the RHR pumps when they are running with the RCS at high pressure (SAMA 1). To reduce the frequency of failures related to the action to transition to recirculation mode, the process could be automated (SAMA 7).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
GG2	2.90E-02	1.012	DG 1-2 (BUS G): GF-F	Cross-tie from the opposite unit is available, but common cause failures limit the credit associated with this capability in the model. Installation of a self-contained, independent swing diesel, not dependent on external support systems, would provide increased defense in depth and should be considered for loss of onsite emergency ac power sources (SAMA 15). Alternatively, a smaller sized emergency DG could be used to power the AFW battery chargers for long term SBO operation and a new, self-cooled, 480 Vac positive displacement pump (PDP) could be used for primary side makeup (SAMA 12).
BB1H	1.42E-02	1.012	Train 2H fails with Recovery - TH=S	This SF is an intermediate SF for Unit 2 power failures. These failures show up in the importance list, but are non-minimal failures that do not directly impact the sequence of events. No SAMAs are required.
SACSS4	3.98E-02	1.012	SEISMIC FAILURE OF AC TURBINE BUILDING (TB) STRUCT SUCCESSFULE: SEIS4, Hazard Levels: 2.00E+00 to 2.500E+00	This SF represents the failure of all vital 4 kVac power given that the turbine building strut does not fail due to the seismic event. In most cases, the 230 kV offsite supply is also failed and power is not available to the site at all. Given that this SF is associated with a large scale seismic event (greater than 1.75g); a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
GX	1.90E-04	1.012	3/3 DIESELS UNAVAILABLE	This is an intermediate SF for GH3, which is failure of DG H given failure of the F and G DGs. Cross-tie from the opposite unit is available, but common cause failures limit the credit associated with this capability in the model. Installation of a self-contained, independent swing diesel, not dependent on external support systems, would provide increased defense in depth and should be considered for loss of onsite emergency ac power sources (SAMA 15). A potential alternate solution is to use a 480 Vac generator to supply the battery chargers for long term AFW support in conjunction with a self-cooled, 480 Vac RCS high pressure injection pump that can be used to make up for normal seal leakage or boil off if SG makeup fails (SAMA 12).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CD1FL	4.55E-02	1.012	FLOOD-ALL SUPPRT AVAILABLE-MAIN FEEDWATER (MFW) PUMPS AVAILABLE	This SF represents the failure of the condensate system in flooding events when all support systems and MFW pumps are available. The top contributor is from a flood sequence in which a pipe from the RWST breaks in the fuel handling building. All AFW pumps and the RWST are lost, as well as RHR due to lack of inventory. Failure of condensate results in loss of all heat removal capability. In other cases, fire protection system breaks in the AFW pump rooms result in failure of AFW, which in combination with F&B and condensate system failure lead to core damage. For fire protection system ruptures, a potential means of mitigating the event would be to provide water level sensors in critical areas, such as those housing the charging pumps, AFW pumps, CCW pumps, and RHR pumps that could actuate on high level to shut down the fire protection pumps when there is not a coincident fire alarm (SAMA 17). These types of events could also potentially be mitigated through the use of portable, engine driven, high pressure RCS and SG injection pumps (SAMA 18).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
GH3	1.87E-01	1.012	DG 1-1 (BUS H) : GF-F,GG-F	This SF represents the failure of DG H given failure of the F and G DGs. Cross-tie from the opposite unit is available, but common cause failures limit the credit associated with this capability in the model. Installation of a self-contained, independent swing diesel, not dependent on external support systems, would provide increased defense in depth and should be considered for loss of onsite emergency ac power sources (SAMA 15). A potential alternate solution is to use a 480 Vac generator to supply the battery chargers for long term AFW support in conjunction with a self-cooled, 480 Vac RCS high pressure injection pump that can be used to make up for normal seal leakage or boil off if SG makeup fails (SAMA 12).
SACSS6	4.50E-01	1.011	SEISMIC FAILURE OF AC TB STRUCT SUCCESSFULE: SEIS6, Hazard Levels: 3.00E+00 to 3.99E+00	This SF represents the failure of all vital 4 kVac power given that the turbine building strut does not fail due to the seismic event. In most cases, the 230 kV offsite supply is also failed and power is not available to the site at all. Given that this SF is associated with a large scale seismic events (>1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZPRSI1	2.80E-01	1.011	Operator action to terminate spurious SI - Instrumentation OK	This SF represents the failure to terminate a fire induced spurious SI signal. In this case, the fire has not degraded the instrumentation used to perform the SI termination action. The DCPP fire procedure already includes guidance on addressing spurious actuation of SI and it is directed to be used for any fire scenario. A potential enhancement to consider would be to include a note identifying the spurious signal actuations that may occur in each fire area with a reference to the attachment that governs the mitigating steps for the associated spurious actuation (SAMA 16).
ZSGALL	9.97E-01	1.011	PCV-19 spuriously opens due to fire - fire impact PCV-19, PCV-20, PCV-21 and PCV-22	This SF represents the fire induced opening of PCV-19 given that all of the AFW atmospheric dump valves (ADVs) are impacted by the fire. This, combined with other failures (generally fire induced), leads to loss of SG makeup capability. The top contributors also all include fire induced small LOCAs such that SG makeup alone cannot mitigate the accident. For the diverse set of fire initiators that include this event, a comprehensive mitigation strategy is considered to be required. These types of events could also potentially be mitigated through the use of portable, engine driven, high pressure RCS and SG injection pumps (SAMA 18).
GYG	5.65E-02	1.010	1/3 DIESELS UNAVAILABLE (BUS G)	This is an intermediate SF for TG1 and similar SFs, which represent the unavailability of DG 2-1. The SF appears in the importance list, but it is related to non-minimal failures that do not directly impact the sequence of events. No SAMAs are required.

Table 4: DC03SA Level 1 Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
SE4	5.61E-04	1.010	REACTOR COOLANT PUMP SEAL COOLING: NO CCW FLOW BUT SUPPORT FOR BOTH CCP	This SF represents the loss of RCP seal cooling when CCW cooling flow is not available. The fire portion of the DC03SA model, and some SGTR scenarios, include credit for the planned installation of the Generation 3 Westinghouse shutdown seals at DCPP. However, the internal events portion of the DC03SA model does not credit the shutdown seals. If credit were applied for the shutdown seals in the internal events portion of the DC03SA model, the seal LOCA scenarios related to the SE4 SF would no longer be risk significant contributors. No SAMAs are considered to be required to address the risk associated with SE4.

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CPFIRE	1.00E-01	1.178	Failure of Isolating the Containment Pen of greater than 2 inches: Failure of Pen 45 valves due to fire	This split fraction (SF) represents the failure to manually isolate the reactor coolant pump (RCP) seal water return lines given a fire induced failure of the valves, which leads to an open pathway from containment that exists prior to core damage. A potential means of improving reliability of the isolation action would be to provide fire area specific guidance that addresses containment isolation valves. In some cases, reference to the severe accident management guidelines (SAMGs) or additional guidance may be appropriate when isolation will result in the loss of a function that is required to prevent core damage (SAMA 21)
SPCET3	7.67E-01	1.163	RCP SEAL COOLING UNAVAILABLE	There are numerous paths that lead to core damage that include the unavailability of RCP seal cooling, but all of the top large early release frequency (LERF) contributors are the result of induced steam generator (SG) tube ruptures (SGTR). These types of events can be prevented by maintaining level in the SGs after core damage to prevent overheating of the SG tubes. A portable, high pressure engine driven SG makeup source with diverse suction supplies can provide this capability (SAMA 2).
OSZ1	5.30E-02	1.162	MANUAL ACTUATION IN EVENT SSPS FAILS: Instrumentation degraded	Addressed in the Level 1 importance list.

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ISCET3	7.10E-02	1.160	INDUCED-SGTR: Loss of seal cooling, smallest leak size, no CST resupply	This SF represents the probability that an induced SG tube rupture occurs. While SG makeup alone cannot necessarily prevent core damage for cases in which primary side inventory has been lost, providing the capability to inject water into the SGs will prevent tube failure. A portable, high pressure engine driven SG makeup source with diverse suction supplies can provide this capability (SAMA 2).
ISCET1	5.80E-02	1.111	INDUCED-SGTR: Loss of SG cooling at setpoint pressure	This SF represents the probability that an induced SG tube rupture occurs. While SG makeup alone cannot necessarily prevent core damage for cases in which primary side inventory has been lost, providing the capability to inject water into the SGs will prevent tube failure. A portable, high pressure engine driven SG makeup source with diverse suction supplies can provide this capability (SAMA 2).
OR1	2.30E-02	1.096	OPERATOR COOLDOWN AND DEPRESSURIZE RCS	Addressed in the Level 1 importance list.
OX1	1.60E-02	1.074	OPERATOR DECIDES TO ISOLATE RUPTURED SG	This SF represents the probability that the operators will fail to isolate a ruptured SG in a tube rupture scenario. It is generally coupled with the failure to cool down the reactor coolant system (RCS) as part of the mitigation process. In these cases, the types of strategies that are available to reduce the LERF are limited, but providing primary side SG isolation valves is a potential means of simplifying the mitigation strategy and terminating the scenario (SAMA 19).

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RECSR	6.50E-02	1.070	Recovery actions for CSR Scenarios from hot shutdown panel (HSP)	Addressed in the Level 1 importance list.
WLF0	1.00E-01	1.065	Both solid state protection system (SSPS) Trains Not available, no fire	This SF, which is a failure of the "B" train of the solid state protection system, is often paired with operator failure to trip the reactor that result in anticipated transient without scram (ATWS) events, which are assumed to result in core damage for seismic initiators. A potential means of reducing the contribution of this SF is to use an alternate signal, such as ATWS mitigating system actuation circuitry (AMSAC), to automate the deenergization of the 480 V busses feeding the rod drive motor generator sets (SAMA 20).
PRB1A	1.76E-01	1.047	Pressure relief (PR) Failed due to PORV 455C 8000B Failure - FOR FIRE AREA 1A and 9A	Addressed in the Level 1 importance list.
SDC6	1.71E-01	1.045	SEISMIC FAILURE OF DC DUE TO FRAGILITY: SEIS6, Hazard Levels: 3.00E+00 to 3.99E+00	This SF represents the seismic failure of 125 V direct current (dc) power. This SF is typically combined with loss of offsite power (LOOP) events, which result in station blackout (SBO) scenarios given that dc power is required for on-site power alignment. Given that this SF is associated with a large scale seismic events (>1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified power-operated relief valve (PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
				water (wells or seawater), and a Hx system (SAMA 4).
ZHTRP2	1.60E-01	1.042	Operator Action - Degraded Instrumentation	Addressed in the Level 1 importance list.
ZSVHES	5.80E-03	1.042	480 V Switchgear Ventilation - Operator Action: No fire damage to flow switches	Addressed in the Level 1 importance list.
PR6BWZ	9.66E-02	1.040	Fire - 456 available, 8000C and 455C failed. Overlaps with PR9. Water Challenge.	Addressed in the Level 1 importance list.
S12	4.82E-05	1.037	SSPS TRAIN A&B FAIL (GENERAL TRANSIENT)	This is an intermediate SF for SB2, which represents failure of the "B" SSPS channel given failure of the "A" channel. There are limited options available to address the sequences where operators fail to manually actuate the safety systems after automatic actuation has failed. This SF is often paired with operator failure to trip the reactor that result in ATWS events, which are assumed to result in core damage for seismic initiators. A potential means of reducing the contribution of this SF is to use an alternate signal, such as AMSAC, to automate the deenergization of the 480 V busses feeding the rod drive motor generator sets (SAMA 20).
SB2	1.48E-02	1.037	SA-F (GENERAL TRANSIENT)	This is an intermediate SF for SB2, which represents failure of the "B" SSPS channel given failure of the "A" channel. The SB2 SF is often paired with operator failure to trip the reactor that result in ATWS events, which are assumed to result in core damage for seismic initiators. A potential means of reducing the contribution of this SF is to use an alternate signal,

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
				such as AMSAC, to automate the deenergization of the 480 V busses feeding the rod drive motor generator sets (SAMA 20).
SA1	3.26E-03	1.037	SSPS TRAIN A: GENERAL TRANSIENT	This SF, which is a failure of the "A" train of the solid state protection system, is often paired with operator failure to trip the reactor that result in ATWS events, which are assumed to result in core damage for seismic initiators. A potential means of reducing the contribution of this SF is to use an alternate signal, such as AMSAC, to automate the deenergization of the 480 V busses feeding the rod drive motor generator sets (SAMA 20).
SDC5	4.41E-02	1.033	SEIS5, Hazard Levels: 2.500E+00 to 3.00E+00	This SF represents the seismic failure of 125-Vdc power. This SF is typically combined with LOOP events, which result in SBO scenarios given that dc power is required for on-site power alignment. Given that this SF is associated with a large scale seismic events (>1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4-kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).
AZAF3	2.70E-02	1.032	UNIT 1 4.16 kV Bus F: HF13/HF14 impacted - Recovery successful	Addressed in the Level 1 importance list.

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZSGALL	9.97E-01	1.029	Fire Impact PCV-19, PCV-20, PCV-21 and PCV-22	Addressed in the Level 1 importance list.
AZAG7	5.00E-01	1.027	HG14 affected - Conditional recovery - Local action	Addressed in the Level 1 importance list.
WLF1	1.00E-01	1.024	WATER LEVEL FOR SUMP RECIRCULATION: Both SSPS Trains Not available, fire with Recovery	This SF represents the failure to close the containment sump discharge valves given the unavailability of both SSPS trains in fire events. A potential improvement would be to include explicit guidance in the fire procedure to manually close either FCV-500 or FCV-501 for fires in zones that could fail SSPS (SAMA 21).
SDC4	9.59E-03	1.023	SEISMIC FAILURE OF DC DUE TO FRAGILITY: SEIS4, Hazard Levels: 2.00E+00 to 2.500E+00	This SF represents the seismic failure of 125 Vdc power. This SF is typically combined with LOOP events, which result in SBO scenarios given that dc power is required for on-site power alignment. An alternate dc generator could be used to either power critical dc buses or to directly power critical dc equipment (SAMA 10). The generator would have to be stored in a seismically qualified area.
SPR6	1.08E-01	1.022	SEIS6, Hazard Levels: 3.00E+00 to 3.99E+00	This top event represents a seismically induced pressure relief/small loss-of-coolant accident (LOCA). Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
				to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).
AWR1	2.93E-04	1.022	Failure to supply water from fire water storage tank or raw water reservoir (non-seismic)	Addressed in the Level 1 importance list.
SVI6	5.09E-02	1.021	ALL FOUR VITAL INSTRUMENT CHANNELS: SEIS6, Hazard Levels: 3.00E+00 to 3.99E+00	This SF represents the failure of all four vital instrument channels in large magnitude seismic events. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).
ZPRSI2	2.80E-01	1.021	Operator action to terminate spurious SI: Degraded instrumentation	Addressed in the Level 1 importance list.
ZSETB7	9.87E-01	1.018	Fire induced loss of thermal barrier cooling: 355, 356, 357, 750 impacted - 355 not recoverable	This SF represents the fire induced loss of thermal barrier cooling. The sequences including these events lead to LERF primarily due to hydrogen burns that fail containment and induced SGTR events. While SG makeup alone cannot necessarily prevent core damage for cases in which primary side inventory has been lost, providing the capability to inject water into the SGs will prevent tube failure. A portable, high pressure engine driven SG makeup source with diverse suction supplies can provide this capability (SAMA 2). The frequency of

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
				containment failure due to hydrogen burns could be reduced by providing a means of eliminating hydrogen buildup in a diverse range of scenarios, such as with a hydrogen igniter system (SAMA 22).
SEL6	4.36E-02	1.018	EXCESSIVE LOCA: SEIS6, Hazard Levels: 3.00E+00 to 3.99E+00	This top event represents a seismically induced excessive LOCA. Given that this SF is associated with a large scale seismic event (greater than 1.75g); a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).
SSG6	4.30E-02	1.018	SEIS6, Hazard Levels: 3.00E+00 to 3.99E+00	This top event represents the seismic failure of the SG supports and postulated failure of the RCS and steam connecting piping. Failure of this top event is modeled as leading to core damage. The top event failure also is modeled as failing containment because it results in high containment internal pressure. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
AF1SB	1.38E-04	1.017	UNIT 1 4.16 KV BUS F: All support available (with recovery - Seismic Group B)	This SF represents the probability that 4 kV Bus F fails in a lower magnitude seismic event. It is typically combined with other failures of Buses G and H along with a failure to trip the reactor due to unavailability of dc power to the shunt trip coils for manual trip (local breaker action not credited). This results in an ATWS. A potential means of reducing the contribution of this SF is to use an alternate signal, such as AMSAC, to automate the deenergization of the 480 V busses feeding the rod drive motor generator sets (SAMA 20).
AY3FGH	2.26E-05	1.017	VITAL AC TRAINS F&G&H FAIL (SEISMISC GROUP B)	This is an intermediate SF for AH3SB, which represents the failure of 4 kV Bus H given failure of Buses F and G in seismic events. The contributors that include this SF are generally combined with the failure to trip the reactor when dc power is not available to the shut trip coils to support a manual trip (local breaker action not credited). This results in an ATWS. A potential means of reducing the contribution of this SF is to use an alternate signal, such as AMSAC, to automate the deenergization of the 480 V busses feeding the rod drive motor generator sets (SAMA 20).
AH3SB	4.67E-01	1.017	UNIT 1 4.16 KV BUS H: DF-S, DG-S, AF-F,AG-F (with recovery) - Seismic Group B	This SF represents the failure of 4 kV Bus H given failure of Buses F and G in seismic events. The contributors that include this SF are generally combined with the failure to trip the reactor when dc power is not available to the shut trip coils to support a manual trip (local breaker action not credited). This results in an ATWS. A potential means of reducing the contribution of this SF is to use an alternate signal, such as AMSAC, to automate the deenergization of the 480 V busses

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
				feeding the rod drive motor generator sets (SAMA 20).
SVZ3R1	2.73E-02	1.017	480V SWITCHGEAR VENTILATION: E-43, S-43 and HD43-SO impacted - run failure	Addressed in the Level 1 importance list.
AG2SB	3.50E-01	1.017	UNIT 1 4.16-KV BUS G: DF-S, AF-F, with recovery (Seismic Group B)	This SF represents the failure of 4 kV Bus G given failure of Bus F in seismic events. The contributors that include this SF are generally combined with the failure to trip the reactor when dc power is not available to the shut trip coils to support a manual trip (local breaker action not credited). This results in an ATWS. A potential means of reducing the contribution of this SF is to use an alternate signal, such as AMSAC, to automate the deenergization of the 480 V busses feeding the rod drive motor generator sets (SAMA 20).
ZPRL3C	4.37E-02	1.016	Normal letdown LOCA due to fire induced/random failures: All components impacted - Recovery of 8149A, B, C impacted. (HEP=0.1)	This event represents a letdown path LOCA with failure of the recovery action to isolate the LOCA pathway by opening the dc supply breakers for the valves. DCPP currently has fire procedures that direct this action for fires in the relevant area and no additional changes to the procedures have been identified that would significantly improve action reliability. A potential enhancement would be to provide fire barriers to protect the cables related to the valves in the letdown path associated with LOCA (Valves 8149A, B, and C, LCV-459, and LCV-460). Ensuring that either LCV-459 or -460 is protected in Area 5A1 could prevent or mitigate the fire induced LOCA (SAMA 14).

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZPRS2F	9.98E-01	1.015	Inadvertent pressurizer spray through aux or normal path: All components impacted	This SF represents the failure to terminate a fire induced spurious safety injection (SI) signal. In this case, the fire has failed the instrumentation used to diagnose the SI termination action. The DCPP fire procedure already includes guidance on addressing spurious actuation of SI and it is directed to be used for any fire scenario. A potential enhancement to consider would be to include a note identifying the spurious signal actuations that may occur in each fire area with a reference to the attachment that governs the mitigating steps for the associated spurious actuation (SAMA 16).
RF3Z	1.60E-01	1.014	FIRE: SWITCHOVER TO RECIRCULATION AFTER SLOCA DEGRADED INSTRUMENTATION	Addressed in the Level 1 importance list.
C2CT3	1.80E-02	1.013	CONTAINMENT FAILURE AT VESSEL BREACH: No high pressure melt ejection (HPME) caused direct containment heating (DCH) (low pressure, or HPME doesn't occur at higher pressure) without spray or containment fan cooling units (CFCUs)	This SF is associated with top event CSCET, which considers containment failure due to RCS blowdown or combustible gas burns. The scenarios including this SF are all large magnitude seismic events. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a heat exchanger system (SAMA 4).

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
L2CT3	3.30E-01	1.013	LARGE CONTAINMENT FAILURE AT VESSEL BREACH: No HPME caused DCH (low pressure, or HPME doesn't occur at higher pressure) without spray, with CFCUs	This SF is associated with top event L2CET, which considers large containment failure due to RCS blowdown or combustible gas burns. The scenarios including this SF are all large magnitude seismic events. Given that this SF is associated with a large scale seismic event (greater than 1.75g); a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4)
PR6GWZ	9.66E-02	1.013	Fire - 456 and 8000B failed. 8000C and 455C available. Overlaps with PR1E. Water Challenge.	Addressed in the Level 1 importance list.
ZTDPHD	1.00E-01	1.013	Failure to control SG 2/3 Water Level: Partial Instruments are available	Addressed in the Level 1 importance list.
BB1G	1.97E-02	1.012	UNIT 2 VITAL AC/DC SYSTEM: Train 2G fails with Recovery - TS=S	Addressed in the Level 1 importance list.
D2F1	2.48E-04	1.012	125-V DC BUS F (BATTERY) - ALL SUPPORT AVAILABLE	This SF represents the unavailability of the Bus F 125 V battery. In most cases, it occurs in scenarios in which all 3 dc divisions have failed. An alternate dc generator could be used to either power critical dc buses or to directly power critical dc equipment (SAMA 10). The

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
				generator would have to be stored in a seismically qualified area.
ZPRL3A	4.37E-02	1.011	All components impacted - Recovery of 8149A, B, C impacted. (HEP=1)	Addressed in the Level 1 importance list.
SDS1	2.17E-02	1.011	RCP Shutdown seals Fail to Actuate	Addressed in the Level 1 importance list.
SSG5	1.25E-02	1.011	SEIS5, Hazard Levels: 2.500E+00 to 3.00E+00	This top event represents the seismic failure of the SG supports and postulated failure of the RCS and steam connecting piping. Failure of this top event is modeled as leading to core damage. The top event failure also is modeled as failing containment because it results in high containment internal pressure. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).
D2G2	1.94E-02	1.010	125-V DC BUS G (BATTERY) - GIVEN D2F=F	This SF represents the unavailability of the Bus G 125 V battery given failure of the Bus F battery. In most cases, it occurs in scenarios in which all 3 dc divisions have failed. An alternate dc generator could be used to either power critical dc buses or to directly power critical dc equipment (SAMA 10). The generator would have to be stored in a seismically qualified area.

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
OP1	2.00E-03	1.010	OPERATOR FAILS TO TERMINATE SAFETY INJECTION	This event represents operator failure to terminate the emergency core cooling system (ECCS) during SGTR initiating event (which are typically nonisolated SGTR scenarios). Given the relatively long time window available for action, combined with the frequent simulator and classroom training associated with this event, it is unlikely any further benefit can be obtained by revising the existing human error probability (HEP) analysis. Providing primary side SG isolation valves (SAMA 19) could potentially simplify the response in these scenarios.
SVI5	1.21E-02	1.010	SEIS5, Hazard Levels: 2.500E+00 to 3.00E+00	This SF represents the failure of all four vital instrument channels in large magnitude seismic events. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).
GXH	3.50E-02	1.010	1/3 DIESELS UNAVAILABLE (BUS H)	GXH is an "Intermediate" SF used to calculate GH1 and other conditional SFs associated with failure of DH 1-1. The top contributors including this event are flooding events in the AFW rooms that include random loss of offsite power. In these scenarios, the condensate feedwater system is unavailable and combined with F&B failure (2/3 PORVs failed: Bus 1H fails PORV 456, and PORV 474 via FCV-584), there are no heat

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
				removal options. A potential approach to restoring SG makeup would be to provide an engine driven SG makeup pump that can be aligned in time to mitigate loss of SG makeup scenarios (SAMA 2).
DA3FGH	2.33E-06	1.010	VITAL DC TRAINS F, G AND H (2 HOUR) UNAVAILABLE	This SF represents the unavailability of all 3 125 Vdc divisions. An alternate dc generator could be used to either power critical dc buses or to directly power critical dc equipment (SAMA 10). The generator would have to be stored in a seismically qualified area.
SO2	5.90E-01	1.010	OPENING AND CLOSING OF SAFETIES: SG SAFETIES OPEN FOR STM/WATER RELIEF	This SF represents either the failure of 1 of the 5 SG safety valves to open, or 2 of the 5 valves to reclose after a challenge. In the top contributors, SO2 is always paired with AO2 in unisolated SGTR events. AO2 represents the failure of the 10 percent steam dump valve to open on the ruptured SG, implying that the SG safety valves are challenged. For LERF events, failure to reclose after a challenge provides a direct pathway to the environment. These events occur after operator failure to perform a cooldown during the SGTR event. The cooldown action is dominated by execution failure from the multitude of steps in the cooldown process. While the importance of this event may be overestimated due to conservative Human Reliability Analysis (HRA) techniques, some changes could be made to reduce the frequency of the sequences containing this action. Primary side isolation valves would simplify both the action to isolate a ruptured SG, the action to cool down/depressurize the RCS after isolation, and help prevent induced SGTR events (SAMA 19). SG flooding is already directed by the DCPP severe accident guidelines to provide scrubbing

Table 5: DC03SA Level 2 (ST1/ST5) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
				of the release. Alignment of makeup to the RWST is already possible at DCPP, but it is not credited to prevent core damage unless cooldown is successful.
AO2	3.38E-03	1.010	ATMOSPHERIC DUMP VALVES (ADVs) OPEN ON DEMAND: 10% STEAM DUMPS OPEN FOR STM/H2O RELIEF	This SF represents either the failure of the ADV to open for pressure control. In the top contributors, SO2 is always paired with AO2 in unisolated SGTR events. For LERF events, failure of the ADVs combined with a challenge to the safety valves and a failure these valves to reclose after a challenge provides a direct pathway to the environment. These events occur after operator failure to perform a cooldown during the SGTR event. The cooldown action is dominated by execution failure from the multitude of steps in the cooldown process. While the importance of this event may be overestimated due to conservative HRA techniques, some changes could be made to reduce the frequency of the sequences containing this action. Primary side isolation valves would simplify both the action to isolate a ruptured SG, the action to cool down/depressurize the RCS after isolation, and help prevent induced SGTR events (SAMA 19). Alignment of makeup to the refueling water storage tank is already possible at DCPP, but it is not credited to prevent core damage unless cooldown is successful.
D2H3	4.87E-01	1.010	D2F-F, D2G-F	The probability of this event reflects the failure of multiple dc buses given the availability of 480 Vac buses. As such, a backup independent dc power supply system capable of being connected to the affected bus in a timely manner may lower the importance of this event (SAMA 10).

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CIA	1.03E-01	1.872	FAILURE OF CONTAINMENT ISOLATION: Fire with Recovery	This split fraction (SF) represents the failure of containment isolation in fire events. Because there are multiple valves associated with this function, there are a large set of fire initiating events and accident evolutions associated with this SF. These types of events could also potentially be mitigated through the use of portable, engine driven, high pressure reactor coolant system (RCS) and steam generator (SG) injection pumps (SAMA 18). The existing Diablo Canyon Power Plant (DCPP) fire procedures already include fire area specific actions to mitigate fire induced damage; however, the actions to address the containment isolation function are general. Another potential enhancement would be to explicitly identify the containment isolation valves that may be impacted for each fire area (SAMA 21).
ZOI5	1.90E-01	1.287	Manual containment Isolation: INST. FOR OPERATOR CUE ARE PARTIALLY FAILED DUE TO FIRE	This SF is associated with the operator action to manually perform containment isolation when the instrumentation used for diagnosis is partially degraded. The existing DCPP fire procedures already include fire area specific actions to mitigate fire induced damage; however, the actions to address the containment isolation function are general. Another potential enhancement would be to explicitly identify the containment isolation valves that may be impacted for each fire area (SAMA 21).

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZHTRP2	1.60E-01	1.212	Operator Action - Degraded Instrumentation	Addressed in the Level 1 importance list.
ZOI6	4.50E-02	1.168	Manual containment Isolation: INSTRUMENTS FOR OPERATOR CUE ARE OK FROM FIRE	This SF is associated with the operator action to manually perform containment isolation when the instrumentation used for diagnosis is not impacted. Because there are multiple valves associated with this function, there are a large set of fire initiating events and accident evolutions associated with this SF. These types of events could also potentially be mitigated through the use of portable, engine driven, high pressure RCS and SG injection pumps (SAMA 18).
PR6BWZ	9.66E-02	1.106	Fire - 456 available, 8000C and 455C failed. Overlaps with PR9. Water Challenge.	Addressed in the Level 1 importance list.
RF3Z	1.60E-01	1.099	FIRE: SWITCHOVER TO RECIRCULATION AFTER SMALL LOSS OF COOLANT ACCIDENT (SLOCA) DEGRADED INSTRUMENTATION	Addressed in the Level 1 importance list.
PR6GWZ	9.66E-02	1.096	Fire - 456 and 8000B failed. 8000C and 455C available. Overlaps with PR1E. Water Challenge.	Addressed in the Level 1 importance list.

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
PRB1A	1.76E-01	1.081	Pressure relief (PR) Failed due to power-operated relief valve (PORV) 455C 8000B Failure - FOR FIRE AREA 1A and 9A	Addressed in the Level 1 importance list.
ZTDPHD	1.00E-01	1.080	Failure to control SG 2/3 Water Level: Partial Instruments are available	Addressed in the Level 1 importance list.
RECSR	6.50E-02	1.075	Recovery actions for cable spreading room (CSR) Scenarios from hot shutdown panel (HSP)	Addressed in the Level 1 importance list.
OSZ1	5.30E-02	1.071	MANUAL ACTUATION IN EVENT SOLID STATE PROTECTION SYSTEM (SSPS) FAILS: Instrumentation degraded	Addressed in the Level 1 importance list.
ZPRSI2	2.80E-01	1.047	Operator action to terminate spurious SI: Degraded instrumentation	Addressed in the Level 1 importance list.
AW4	1.61E-02	1.045	SUPPORT FOR BOTH MOTOR-DRIVEN (MD) PUMPS UNAVAILABLE	Addressed in the Level 1 importance list.
GXH	3.50E-02	1.043	1/3 DIESELS UNAVAILABLE (BUS H)	Addressed in the Level 1 importance list.

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
P2CET3	2.82E-01	1.041	RCS PRESSURE AT VESSEL BREACH EXCEEDS 650 PSIA	This SF is linked to scenarios for which the RCS is at intermediate pressure at the time of vessel breach. They include primarily large magnitude seismic events and fire events in which 480 V switchgear room cooling fails. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a heat exchanger (Hx) system (SAMA 4). For the fire events, containment failure is linked to hydrogen burns. The frequency of containment failure due to hydrogen burns could be reduced by providing a means of eliminating hydrogen buildup in a diverse range of scenarios, such as with a hydrogen igniter system (SAMA 22).
AWFZ	5.24E-01	1.039	No support for AFWP2, AFWP3 and fire impacts on AFWP1.	Addressed in the Level 1 importance list.
ZSGALL	9.97E-01	1.038	Fire limpact PCV-19, PCV-20, PCV-21 and PCV-22	Addressed in the Level 1 importance list.

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZPRL3A	4.37E-02	1.038	Normal letdown loss-of-coolant accident (LOCA) due to fire induced/random failures: All components impacted - Recovery of 8149A,B,C impacted. (HEP=1)	Addressed in the Level 1 importance list.
AZAF3	2.70E-02	1.036	UNIT 1 4.16 KV BUS F: HF13/HF14 impacted - Recovery successful	Addressed in the Level 1 importance list.
ZTDPHS	5.00E-02	1.033	Failure to control SG 2/3 Water Level: All Instruments are available	Addressed in the Level 1 importance list.
PRC1A	1.73E-01	1.033	PR Failed due to PORV 456C 8000C Failure - FOR FIRE AREA 1A and 9A	Addressed in the Level 1 importance list.
RF1Z	8.68E-03	1.033	FIRE: SWITCHOVER AFTER SLOCA OR bleed and feed (B&F) WITH containment spray (CS) FAILED	Addressed in the Level 1 importance list.
HRF23A	6.00E-01	1.030	Fire – Heat removal Fails due to ZHR23A fails: NO FLOW PATH FROM residual heat removal (RHR) TO HIGH PRESSURE PUMPS:	Addressed in the Level 1 importance list.

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
PR6AW1	9.66E-02	1.030	PRESSURE RELIEF: Fire - 8000C, 456 available, 455C failed. This will overlap with split fraction PRM. Water Challenge. Block valve closure fails.	Addressed in the Level 1 importance list.
OB1Z2	1.34E-01	1.029	Fire - Loss of Instrument Air (human error probability [HEP] successful) and Instrumentation Degraded	Addressed in the Level 1 importance list.
SIZCR6	8.41E-01	1.028	8974A, and All ZSI1 components impacted	Addressed in the Level 1 importance list.
ZPRIS2	1.50E-01	1.027	Instrumentation degraded	Addressed in the Level 1 importance list.
LSCET1	5.00E-01	1.027	INDUCED PORV (OR PRESSURIZER SAFETY) FAILURE	This SF represents the probability that a PORV has failed in the open position after repeated cycling at elevated temperatures, which leads to a low pressure RCS at vessel breach and containment typically fails due to long term overpressurization. The sequences that include PORV failures are diverse and include internal events initiators, fire scenarios, and seismic events. These types of events could also potentially be mitigated through the use of portable, engine-driven, high pressure RCS and SG injection pumps (SAMA 18).

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZSETB7	9.87E-01	1.025	355, 356, 357, 750 impacted - 355 not recoverable	This SF represents the fire induced loss of thermal barrier cooling. The sequences including these events are represented by a wide range of fire events that lead to long term containment overpressurization failures. These types of events could also potentially be mitigated through the use of portable, engine-driven, high pressure RCS and SG injection pumps (SAMA 18).
ZAH7	5.00E-01	1.022	4.16 kV Bus H fails due to fire: HH14 affected - Conditional recovery - Local action	Addressed in the Level 1 importance list.
SDS1	2.17E-02	1.021	RCP Shutdown seals Fail to Actuate	Addressed in the Level 1 importance list.
ZHTRP3	6.50E-03	1.020	Operator Action - Instrumentation OK	Addressed in the Level 1 importance list.
AZAH7	5.00E-01	1.019	HH14 affected - Conditional Recovery - Local action	Addressed in the Level 1 importance list.
OG2305	6.04E-01	1.019	AVAILABILITY OF POWER FROM 230 kV OFFSITE GRID: 52HG15 impacted	The offsite power failures are generally combined with a failure of an emergency diesel generator (EDG), a 4 kV bus/supply failure, and a 480 Vac bus/supply failure, or some combination of similar events. Typically, the G 480 Vac Bus is not available to support turbine-driven (TD) auxiliary feedwater (AFW) and an alternate means of SG makeup is required. Because there are often induced LOCAs, primary side makeup is also necessary. These types of events could also

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
				potentially be mitigated through the use of portable, engine-driven, high pressure RCS and SG injection pumps (SAMA 18).
C2CT3	1.80E-02	1.019	CONTAINMENT FAILURE AT VESSEL BREACH: No high pressure melt ejection (HPME) caused direct containment heating (DCH) (low pressure, or HPME doesn't occur at higher pressure) without spray or containment fan cooling units (CFCUs)	This SF is associated with top event CSCET, which considers containment failure due to RCS blowdown or combustible gas burns. The scenarios including this SF are all large magnitude seismic events. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).
AWR1	2.93E-04	1.018	Failure to supply water from fire water storage tank or raw water reservoir (non-seismic)	Addressed in the Level 1 importance list.
GF1	3.50E-02	1.018	DG 1-3 (BUS F) STARTS & RUNS FOR 6 HR	Addressed in the Level 1 importance list.
AZAG7	5.00E-01	1.018	HG14 affected - Conditional recovery - Local action	Addressed in the Level 1 importance list.
BB1G	1.97E-02	1.017	UNIT 2 VITAL AC/DC SYSTEM: Train 2G fails with Recovery - TS=S	Addressed in the Level 1 importance list.

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
GH4G	3.52E-02	1.017	UNIT 1 BUS H DIESEL GENERATOR: DG 1-1 (BUS H) : GF-S, GG-B	This SF is associated with a failure of Diesel Generator (DG) 1-1, primarily for fires in the 4-A-1 area (Chemical Lab Area, Bus G compartment). The scenario including this SF is typically associated with fires in the 4-A-1 Area (Chemical Lab Area, Bus G compartment). In these cases, the fire impacts RHR Pump 1-1 and 480 V Bus G in combination with the random failure of DG 1-1 and fire induced failure of 4 kV Bus G. The result is a failure of power to the DG fuel oil system, which leads to a station blackout (SBO) as it is also combined with a failure to align the backup power supply to the fuel oil system. DCPP has a viable recovery option for this type of event, but the action to perform the task is impacted by degraded instrumentation and it has failed. These types of events could also potentially be mitigated through the use of portable, engine-driven, high pressure RCS and SG injection pumps (SAMA 18).
GXF	3.50E-02	1.017	1/3 DIESELS UNAVAILABLE (BUS F)	Addressed in the Level 1 importance list.

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZFO32	1.90E-01	1.015	Failure to Align Backup Power Supply: Partial Instruments are available	This SF represents the failure to align a diesel fuel oil pump to its backup power supply when the instrumentation required for diagnosis of the action has been degraded by a fire event. The scenario including this SF are typically associated with fires in the 4-A-1 area (Chemical Lab Area, Bus G compartment). In these cases, the fire impacts RHR pump 1-1 and 480 V Bus G in combination with the random failure of DG 1-1 and fire induced failure of 4 kV Bus G. The result is a failure of power to the DG fuel oil system, which leads to an SBO as it is also combined with a failure to align the backup power supply to the fuel oil system. DCPP has a viable recovery option for this type of event, but the action to perform the task is impacted by degraded instrumentation and it has failed. These types of events could also potentially be mitigated through the use of portable, engine driven, high pressure RCS and SG injection pumps (SAMA 18).
SCT6	5.14E-01	1.015	RELAY CHATTER: SEIS6, Hazard Levels: 3.00E+00 to 3.99E+00	This SF represents the failure of the emergency alternating current (ac) power system due to seismically induced relay chatter. Without relay reset, onsite ac sources cannot be aligned to required loads. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV)

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
				capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).
ZPRS2F	9.98E-01	1.015	Inadvertent pressurizer spray through aux or normal path: All components impacted	For scenarios that include fire induced pressurizer spray actuation induced LOCAs, many of the contributors initially have an RHR pump available for mitigation. Failure to trip the deadheaded pump before it is damaged leads to loss of heat removal capability and subsequent containment overpressurization. A potential means of precluding the need for the operators to remember to trip the RHR pumps would be to install a normally open component cooling water (CCW) flow bypass line around the RHR Hx outlet valve. This would ensure that minimum cooling flow would be available to prevent damage to the RHR pumps when they are running with the RCS at high pressure (SAMA 1).
C2CT11	7.20E-03	1.014	CONTAINMENT FAILURE AT VESSEL BREACH: High or setpoint pressure, w/o sprays or CFCUs, HPME cause DCH	This SF is related to the failure of containment at the time of vessel breach. The contributors including this SF are primarily large magnitude seismic events. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
DB4F	5.64E-03	1.014	125-V DC BUS F - LONG TERM (TRAIN 11): 125-V DC VITAL POWER BUSES: Train DF - (BTC11=S, BTC121=F)	This is an intermediate SF for DF4, which represents the unavailability of direct current (dc) Bus F. An alternate dc generator could be used to either power critical dc buses or to directly power critical dc equipment (SAMA 10). The generator would have to be stored in a seismically qualified area.
SOP6	9.98E-01	1.014	SEIS6, Hazard Levels: 3.00E+00 to 3.99E+00	This SF represents the loss of all offsite power and is based on the 230 kV switchyard seismic fragility, which is significantly stronger than the 500 kV switchyard seismic fragility. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).
ZPRSI1	2.80E-01	1.014	Operator action to terminate spurious SI: Instrumentation OK	Addressed in the Level 1 importance list.
DB2H	5.64E-03	1.014	125-V DC VITAL POWER BUSES: Train DH - BTC132=S, BTC131=F	This is an intermediate SF for DH10, which represents the unavailability of dc Bus H. An alternate dc generator could be used to either power critical dc buses or to directly power critical dc equipment (SAMA 10). The generator would

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
				have to be stored in a seismically qualified area.
DF4	5.64E-03	1.014	125-V DC BUS F - LONG TERM (TRAIN 11): BTC11=S, BTC121=F	This SF represents the unavailability of dc Bus F. An alternate dc generator could be used to either power critical dc buses or to directly power critical dc equipment (SAMA 10). The generator would have to be stored in a seismically qualified area.
ZSVHES	5.80E-03	1.013	480-V Switchgear Ventilation - Operator Action: No fire damage to flow switches	Addressed in the Level 1 importance list.
OG230S	6.63E-01	1.013	AVAILABILITY OF POWER FROM 230- kV OFFSITE GRID: 52HG15 impacted - for scenario ZTRY22F1	This SF represents the failure of offsite power from the 230 kV source in a fire event. The scenario including this SF is typically associated with fires in the 4-A-1 Area (Chemical Lab Area, Bus G compartment). In these cases, the fire impacts RHR pump 1-1 and 480 V Bus G in combination with the random failure of DG 1-1 and fire induced failure of 4 kV Bus G. The result is a failure of power to the DG fuel oil system, which leads to an SBO as it is also combined with a failure to align the backup power supply to the fuel oil system. DCPP has a viable recovery option for this type of event, but the action to perform the task is impacted by degraded instrumentation and it has failed. These types of events could also potentially be mitigated through the use of portable, engine-driven, high pressure RCS and SG injection pumps (SAMA 18).

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
AWBB	6.23E-03	1.013	SUPPORT FOR THE TD PUMP AND MD PUMP 1-2 UNAVAILABLE	This SF represents the failure of MD AFW Pump 13 given the unavailability of the other two pumps. A potential approach to restoring SG makeup would be to provide an engine driven SG makeup pump that can be aligned in time to mitigate loss of SG makeup scenarios (SAMA 2).
SCB6	4.67E-02	1.013	COMPONENT COOLING WATER (CCW) BYPASS: SEIS6, Hazard Levels: 3.00E+00 to 3.99E+00	This is a seismic-specific split fraction that represents the loss of CCW cooling in very large magnitude seismic events. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).
GYG	5.65E-02	1.013	1/3 DIESELS UNAVAILABLE (BUS G)	This is an intermediate SF for TG1 and similar SFs, which represent the unavailability of DG 2-1. The SF appears in the importance list, but it is related to non-minimal failures that do not directly impact the sequence of events. No SAMAs are required.

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
IPCET2	1.20E-01	1.013	INDUCED RCS HOT LEG OR SURGE LINE FAILURE: RCS at setpoint pressure, Seal LOCA, smallest leak size, no condensate storage tank (CST) resupply, no RCS failures	They include primarily large magnitude seismic events and fire events in which 480 V switchgear room cooling fails. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4). For the fire events, the action to align portable switchgear ventilation is credited, (instrumentation required for diagnosis is not degraded) and it fails. Loss of all ac power is considered to be an adequate cue to credit the alignment of an additional mitigation strategy, such as the use of portable, engine driven, high pressure RCS and SG injection pumps (SAMA 18).
SIZCR4	8.73E-01	1.013	TOP EVENT SI: 8976, 8974B, and all ZSI2 components impacted	This SF represents the failure of the safety injection (SI) top event given fire impact on the refueling water storage tank (RWST) suction and recirculation valves. The sequences that include this SF often include RHR pump failure due to the failure to trip the pumps when operating in the "deadhead" condition. A potential means of precluding the need for the operators to remember to trip the RHR pumps would be to install a normally open CCW flow bypass line around the

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
				RHR Hx outlet valve. This would ensure that minimum cooling flow would be available to prevent damage to the RHR pumps when they are running with the RCS at high pressure (SAMA 1).
CI4	1.03E-01	1.013	SSPS Trains A and B Not Avail but Manual Recovery Avail	This represents failure of containment isolation when both SSPS trains are unavailable. The primary contributors to these scenarios are flooding events that lead to failure of all three dc batteries/busses. Credit is already taken for manual isolation of the flooding event. A portable dc generator could be used to directly power critical loads in the event that batteries have failed (SAMA10).
PRA1A	1.96E-01	1.012	PRESSURE RELIEF: PR Failed due to PORV 474 8000A failure - for fire area 9A	This SF represents the fire related failures of PORV 474 Block Valve 8000A. The scenarios generally include either a failure to swap recirculation mode or failure to trip deadheaded RHR pumps to prevent pump damage. Automating the swap to recirculation mode could improve the reliability of the function (SAMA 7). A potential means of precluding the need for the operators to remember to trip the RHR pumps would be to install a normally open CCW flow bypass line around the RHR Hx outlet valve. This would ensure that minimum cooling flow would be available to prevent damage to the RHR pumps when they are running with the RCS at high pressure (SAMA 1).

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
SCT5	2.86E-01	1.012	RELAY CHATTER: SEIS5, Hazard Levels: 2.500E+00 to 3.00E+00	This SF represents the failure of the emergency ac power system due to seismically induced relay chatter. Without relay reset, onsite ac sources cannot be aligned to required loads. Given that this SF is associated with a large scale seismic event (greater than 1.75g), a new mitigating system capable of responding after seismic events (potentially up to 4g) is considered to be required. Such a system would include a 4 kV power source, a core spray type injection system (with a qualified PORV) capable of filling the reactor cavity, a connection to a large seismically qualified source of water (wells or seawater), and a Hx system (SAMA 4).
GH4F	3.52E-02	1.012	UNIT 1 BUS H DIESEL GENERATOR: DG 1-1 (BUS H) : GF-B,GG-S	This SF represents the failure of DG 1-1 given success of DG 1-2 (and bypass of DG 1-3). In top contributors, the failure of DG 1-1 is combined with fire induced failure of SI Pump 1-2, leaving no adequate high pressure injection supply to mitigate the fire induced LOCA. Cross-tie from the opposite unit is available, but common cause failures limit the credit associated with this capability in the model. Installation of a self-contained, independent swing diesel, not dependent on external support systems, would provide increased defense in depth and should be considered for loss of onsite emergency ac power sources (SAMA 15).

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
ZSG234	9.83E-01	1.012	PCV-19 spuriously opens due to fire: fire impact PCV-20, PCV-21 and PCV-22	This SF represents the failure of PCV-19 to open for steam relief given fire impact on the other 3 ADVs. Many of the scenarios that include this SF also include failure of the charging pumps due to loss of cooling to the pumps, which impacts mitigation of a fire induced LOCA. In these cases, instrumentation for diagnosis is degraded and there is limited time for the 30-minute alternate cooling alignment from fire water. A potential improvement would be to provide a hard pipe connection between the fire water system and the charging pump cooling lines to simplify the alignment and reduce the time required for the action (SAMA 23).
BB1H	1.42E-02	1.011	Train 2H fails with Recovery - TH=S	Addressed in the Level 1 importance list.
IPCET1	7.20E-01	1.011	INDUCED RCS HOT LEG OR SURGE LINE FAILURE	This SF represents the probability of failure of the RCS hot leg or surge line after core damage, which occurs for a diverse range of events. A potential means of preventing these failures would be to provide an independent means of adding water to the RCS at high pressure. These types of events could also potentially be mitigated through the use of portable, engine-driven, high pressure RCS and SG injection pumps (SAMA 18).
GYF	5.65E-02	1.011	DEG 2-3 GENERATOR FAILURE (1/3): 1/3 DIESELS UNAVAILABLE (BUS F)	This is an intermediate SF for TF1 and similar SFs, which represent the unavailability of DG 2-3. The SF appears in the importance list, but it is related to nonminimal failures that do not directly impact

Table 6: DC03SA Level 2 (ST2) Importance List Review

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
				the sequence of events. No SAMAs are required.
FO2AZ	4.34E-03	1.010	FUEL OIL TRANSFER SYSTEM: SUPPORT FOR TRAIN 0-1 AVAIL; FIRE INDUCED FAILURE OF TRAIN 0-2	The fuel oil transfer system failures are generally combined with a failure of an EDG, a 4 kV bus/supply failure, and a 480 Vac bus/supply failure, or some combination of similar events. Typically, the 480 Vac Bus G is not available to support TD AFW and an alternate means of SG makeup is required. Because there are often induced LOCAs, primary side makeup is also necessary. These types of events could also potentially be mitigated through the use of portable, engine-driven, high pressure RCS and SG injection pumps (SAMA 18).

Table 7a: SAMA 8 PRA Results Summary for DC03SA

	CDF	Dose-Risk	OECR
Base Value	8.47E-05	98.22	$272,281
SAMA Value	8.25E-05	97.27	$267,993
Percent Change	2.7%	1.0%	1.6%

Table 7b: SAMA 8 Internal Events Results By Release Category for DC03SA

Release Category	ST1	ST2	ST3	ST4	ST5	ST6	Total
$Frequency_{BASE}$	6.54E-06	6.69E-06	6.24E-05	1.76E-06	4.00E-06	2.10E-06	**8.35E-05**
$Frequency_{SAMA}$	6.51E-06	6.42E-06	6.07E-05	1.71E-06	3.95E-06	2.02E-05	**8.13E-05**
$Dose\text{-}Risk_{BASE}$	64.29	6.42	1.55	1.35	24.60	0.01	**98.22**
$Dose\text{-}Risk_{SAMA}$	63.99	6.16	1.51	1.31	24.29	0.01	**97.27**
$OECR_{BASE}$	$79,788	$48,569	$730	$9,592	$133,600	$2	**$272,281**
$OECR_{SAMA}$	$79,422	$46,609	$710	$9,320	$131,930	$2	**$267,993**

Table 8: SAMA 8 Averted Cost-Risk for DC03SA

Unit	Base Case Cost-Risk	Revised Cost-Risk	Averted Cost-Risk
Unit 1	$9,640,262	$9,481,348	$158,914

Table 9: SAMA Quantification Results Summary for DC03SA

SAMA Case Identifier	DC03SA PRA Frequencies (per year)							
	ST1 - LGEARLY (RC04U)	ST2 - SMEARLY (RC16U)	ST3 - LATE (RC10)	ST4 - BYPASS w AFW (RC17)	ST5 - ISLOCA (RC18)	ST6 - INTACT (RC20)	RC Total	CDF total
DC03SA Baseline Results	6.54E-06	6.69E-06	6.24E-05	1.76E-06	4.00E-06	2.10E-06	**8.35E-05**	8.47E-05
SAMA 1	6.52E-06	5.53E-06	5.53E-05	1.56E-06	3.81E-06	2.08E-06	**7.48E-05**	7.59E-05
SAMA 2	6.50E-06	5.94E-06	5.68E-05	1.66E-06	3.91E-06	2.02E-06	**7.68E-05**	7.79E-05
SAMA 3	5.35E-06	6.26E-06	5.95E-05	1.68E-06	3.92E-06	2.03E-06	**7.87E-05**	7.98E-05
SAMA 5	6.54E-06	6.65E-06	6.18E-05	1.75E-06	3.99E-06	2.10E-06	**8.28E-05**	8.41E-05
SAMA 6	6.22E-06	6.59E-06	6.00E-05	1.69E-06	3.93E-06	1.86E-06	**8.03E-05**	8.13E-05
SAMA 7	6.52E-06	5.89E-06	5.86E-05	1.66E-06	3.90E-06	2.09E-06	**7.87E-05**	7.97E-05
SAMA 8	6.51E-06	6.42E-06	6.07E-05	1.71E-06	3.95E-06	2.02E-06	**8.13E-05**	8.25E-05
SAMA 9	6.52E-06	6.59E-06	6.12E-05	1.74E-06	3.98E-06	2.10E-06	**8.21E-05**	8.33E-05
SAMA 10	4.53E-06	6.92E-06	6.10E-05	1.76E-06	4.00E-06	1.27E-06	**7.95E-05**	8.06E-05
SAMA 12	4.53E-06	6.92E-06	6.10E-05	1.76E-06	4.00E-06	1.27E-06	**7.95E-05**	8.06E-05
SAMA 14	6.36E-06	6.40E-06	6.00E-05	1.69E-06	3.94E-06	2.06E-06	**8.05E-05**	8.16E-05
SAMA 16	6.41E-06	6.33E-06	6.08E-05	1.71E-06	3.96E-06	2.11E-06	**8.13E-05**	8.22E-05
SAMA 17	6.53E-06	6.67E-06	5.95E-05	1.70E-06	3.94E-06	2.09E-06	**8.04E-05**	8.16E-05
SAMA 20	4.36E-06	7.81E-06	6.30E-05	1.79E-06	4.04E-06	2.10E-06	**8.31E-05**	8.43E-05
SAMA 21	4.77E-06	7.83E-07	7.10E-05	1.80E-06	4.05E-06	1.48E-06	**8.39E-05**	8.48E-05
SAMA 22	6.44E-06	6.69E-06	6.25E-05	1.76E-06	4.00E-06	2.12E-06	**8.35E-05**	8.47E-05
SAMA 23	6.54E-06	6.68E-06	6.24E-05	1.76E-06	4.00E-06	2.10E-06	**8.35E-05**	8.47E-05

Table 10: 95th Percentile SAMA Results Comparison, DC03 Vs. DC03SA

SAMA ID	Implementation Cost (per unit)	Averted Cost Risk (DC03 95th)	Net Value (DC03 95th)	Averted Cost Risk (DC03SA 95th)	Net Value (DC03SA 95th)	Change in Cost Effectiveness?
SAMA 1	$3,020,424	$1,752,681	-$1,267,743	$1,753,554	-$1,266,870	No
SAMA 2	$17,492,616	$2,378,541	-$15,114,075	$1,190,802	-$16,301,814	No
SAMA 3	$376,342	$2,535,861	$2,159,519	$2,558,997	$2,182,655	No
SAMA 5	$3,133,404	$93,657	-$3,039,747	$98,004	-$3,035,400	No
SAMA 6	$9,993,910	$975,312	-$9,018,598	$980,445	-$9,013,465	No
SAMA 7	$10,616,468	$1,019,664	-$9,596,804	$1,045,962	-$9,570,506	No
SAMA 8	$1,072,493	$1,752,681	$680,188	$476,742	-$595,751	Yes
SAMA 9	$25,520,160	$215,031	-$25,305,129	$246,618	-$25,273,542	No
SAMA 10	$22,572,878	$2,441,985	-$20,130,893	$3,231,408	-$19,341,470	No
SAMA 12	$13,560,218	$2,441,985	-$11,118,233	$3,231,408	-$10,328,810	No
SAMA 14	$5,620,896	$809,154	-$4,811,742	$810,318	-$4,810,578	No
SAMA 16	$372,788	$677,646	$304,858	$663,717	$290,929	No
SAMA 17	$9,610,440	$439,011	-$9,171,429	$443,073	-$9,167,367	No
SAMA 20	$11,173,059	$3,564,048	-$7,609,011	$2,687,982	-$8,485,077	No
SAMA 21	$256,817	$4,998,399	$4,741,582	$4,984,902	$4,728,085	No
SAMA 22	$13,083,120	$146,466	-$12,936,654	$150,525	-$12,932,595	No
SAMA 23	$491,021	$8,118	-$482,903	$5,826	-$485,195	No

Table 11: Impact of Binning Truncated Frequency to ST5 in Conjunction with the 95th Percentile PRA Results

DC03 Vs. DC03SA

SAMA ID	Implementation Cost (per unit)	Averted Cost Risk (DC03)	Net Value (DC03)	Averted Cost Risk (DC03SA)	Net Value (DC03SA)	Change in Cost Effectiveness?
SAMA 1	$3,020,424	$2,006,730	-$1,013,694	$2,013,102	-$1,007,322	No
SAMA 2	$17,492,616	$2,622,894	-$14,869,722	$1,391,844	-$16,100,772	No
SAMA 3	$376,342	$2,676,513	$2,300,171	$2,703,105	$2,326,763	No
SAMA 5	$3,133,404	$110,529	-$3,022,875	$117,048	-$3,016,356	No
SAMA 6	$9,993,910	$1,073,652	-$8,920,258	$1,080,687	-$8,913,223	No
SAMA 7	$10,616,468	$1,163,133	-$9,453,335	$1,193,169	-$9,423,299	No
SAMA 8	$1,072,493	$2,006,730	$934,237	$543,492	-$529,001	Yes
SAMA 9	$25,520,160	$253,227	-$25,266,933	$289,614	-$25,230,546	No
SAMA 10	$22,572,878	$2,538,462	-$20,034,416	$3,354,510	-$19,218,368	No
SAMA 12	$13,560,218	$2,538,462	-$11,021,756	$3,354,510	-$10,205,708	No
SAMA 14	$5,620,896	$898,575	-$4,722,321	$902,535	-$4,718,361	No
SAMA 16	$372,788	$749,736	$376,948	$738,450	$365,662	No
SAMA 17	$9,610,440	$529,590	-$9,080,850	$535,269	-$9,075,171	No
SAMA 20	$11,173,059	$3,584,343	-$7,588,716	$2,700,003	-$8,473,056	No
SAMA 21	$256,817	$4,994,148	$4,737,331	$4,980,264	$4,723,447	No
SAMA 22	$13,083,120	$147,450	-$12,935,670	$150,897	-$12,932,223	No
SAMA 23	$491,021	$8,913	-$482,108	$7,062	-$483,959	No