CALLAWAY PLANT UNIT 1
LICENSE RENEWAL APPLICATION

CLARIFICATION OF RESPONSES TO SAMA RAIs TO THE CALLAWAY LRA

1. RAI 1.a

The response states that for the new model, consequential loss of offsite power (LOSPs) account for 28 percent of the station blackout (SBO) frequency and only 2.5 percent of the core damage frequency (CDF). This indicates that the benefit from an SBO or LOSP mitigating SAMA should be increased to account for the omission of consequential LOSPs. Also, the impact on other SAMAs of increase in total CDF should be considered. If it is assumed that the likelihood of an SBO is the same for the consequential LOSP as it is for the LOSP initiator, the above indicates that the total SBO frequency (and therefore total LOSP frequency) is approximately 39 percent higher than the frequency due solely to the LOSP initiator alone. Incorporating this in the Rev. 4B probabilistic risk assessment (PRA) results yields an increase in CDF of 2.17E-06 (39 percent of 5.58E-06) or 13 percent of the SAMA baseline CDF of 1.66E-05. The NRC staff plans to discuss this in the safety evaluation report (SER) and consider these factors in determining the cost-beneficial SAMAs. Based on current information, while several SAMAs are marginally cost-beneficial at the 95th percentile, considering the conservatisms in the assessment, the staff would not consider them to be cost-beneficial. This conclusion could change due to the responses to other requests for clarifications. Clarify this information.

Callaway Response

This request was clarified during the call, no further response is necessary. See Reference 4.

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

2. RAI 2.d

The response does not provide a response to the last portion of the RAI which states:

> "Also, if the source terms for each release category are not bounding, then provide justification of how the impact of higher source term sequences are accounted for in determining the benefit of potential SAMAs, or provide a sensitivity analysis using bounding case source terms."

While the response indicates that both likelihood and potential offsite effects were considered for large early release frequency (LERF) categories, no details are provided, and further, for other release categories, the most likely sequence was chosen. Provide further justification that the source terms selected provide an adequate analysis of the benefit of each SAMA.

Callaway Response

The representative sequences for each LERF release category considered both the likelihood and consequences, while each non-LERF release category utilized the most likely contributors. For all release categories, the dominant Level 1 and Level 2 sequences were identified and considered down to at least a 10% contribution, sometimes less. Based on engineering judgment, none of these dominant sequences were expected to increase the consequences more than the chosen representative sequence. More severe (bounding) scenarios could have been considered, but would have a much lower frequency (at most a 10% contribution). Therefore, for all release categories, sequences that could have had higher consequences would have much lower frequencies, and therefore not be expected to have a great effect on the SAMA results. There are no specific sensitivity runs that use truly bounding consequences for every release category.

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

3. RAI 5.a

The response provides a description of NFPA 805 FPRA results in terms of important fire areas, scenarios and modifications identified in the 805 transition LAR. The 805 LAR modifications were included as SAMAs and considered cost-beneficial. No other fire related SAMAs were considered. It is not clear if the 805 FPRA results were reviewed to determine if there would be any further modifications that might be cost-beneficial. Provide the core damage frequency of the important fire scenarios from the NFPA FPRA. Also provide a discussion of the potential for cost-beneficial mitigation of the risk of the important fire areas and/or fire scenarios considering their contribution to the total Callaway CDF.

Callaway Response

There was no formal review for SAMAs beyond the identified modifications. The NFPA-805 fire PRA was not completed at the time the SAMA analysis was performed. The fire PRA team position was that no other items should be considered under the NFPA-805 transition process, although this was not performed as a formal SAMA assessment. The Level 2 and Level 3 PRA models used to determine the benefits of SAMA items are based on PRA Update 4b. They cannot interface with the new Fire PRA without extensive modification and analysis. In addition, the NFPA-805 fire PRA is still undergoing changes due to additional plant modifications being installed.

The current Callaway fire PRA results show 14 fire scenarios that are individually greater than 1% of Fire CDF. These scenarios are listed in Enclosure 2, Table 1.

These 14 scenarios make up approximately 56% of the total fire CDF and 7 of the 14 scenarios are dominated by RCP seal LOCA with additional contributions from seal LOCA in several other scenarios. Callaway is scheduled to install the SHIELD™ (no-leakage) RCP seals (SAMA 58) in Refueling Outage 19 (RF19), Spring 2013, which will address a large percentage of the fire risk significant scenarios. In addition, the risk profile will be so significantly changed that it is not warranted to evaluate any further changes until the PRA modeling for the SHIELD™ seals is completed following RF19.

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

4. RAI 5.b

While the response states:

> "The 1999 internal flooding analysis used as a basis for the SAMA identified only one flood that was below the screening value used. After implementation of the internal flooding task force recommendations, this flood was considered an acceptable risk and no further actions were needed."

it does not discuss if the results of current internal flooding analysis were reviewed to identify potential cost-beneficial SAMAs. The Update 5 internal flooding analysis CDF of 6.21E-06 is sufficiently large that cost-beneficial SAMAs for important flood sequences are possible. Mitigating an internal flood scenario that has a CDF of approximately 1.1E-06, or 18% of the new internal flood total CDF, would be cost-beneficial at the 95th percentile at the minimum hardware cost of $100,000. A flood scenario with a CDF of 1.8E-07, or 2.8% of the new internal flood CDF, would be cost-beneficial at the minimum procedure cost of $15,000. Provide the CDF of the important internal flooding scenarios or sequences from the Update 5 internal flooding analysis and a discussion of the potential for their cost-beneficial mitigation considering their contribution to the total Callaway CDF.

Callaway Response

The Update 5 Internal Flooding analysis was not reviewed in detail to identify potential cost-beneficial SAMAs. This flooding analysis was not available at the time the SAMA analysis was performed. The Update 5 Internal Flooding analysis is based on a significantly different PRA model than the model used to calculate the SAMA benefits. In order to determine benefits from the Update 5 PRA, the full Level 2 PRA model and Level 3 PRA models would require extensive modification.

The current Callaway Internal Flooding analysis results show 17 flooding scenarios that are greater than 1% of Flooding CDF. These scenarios are listed in Enclosure 2, Table 2.

These 17 scenarios make up approximately 70% of the total internal flooding CDF, some of which are primarily seal LOCA events with additional seal LOCA impact in other scenarios. Although no formal SAMA exists specifically for seal LOCA flood zones, original SAMA 58 is applicable. Callaway is scheduled to install the SHIELD™ (no-leakage) RCP seals in Refueling Outage 19 (RF19), Spring 2013, which will address associated internal flooding scenarios. The risk profile will be changed to the extent that it is not warranted to evaluate any further changes until the PRA modeling for the SHIELD™ seals is completed following RF19.

SAMA 160, modification to change the impact of flooding through the Control Building dumbwaiter, was added while the internal flooding analysis was still being performed. Personnel participating in the internal flooding analysis had identified this flood path as potentially risk significant and having a low cost of implementation. These personnel also participated in the SAMA Expert Panel Review and added this item to the list of SAMAs.

Analysis is currently underway to determine a more realistic flood height capability for certain plant doors affecting internal flooding. It would limit flood propagation if the evaluation shows the doors are currently capable of higher flood heights or if these doors could be modified to increase their capability to a certain critical flood height. The results of the analysis will be considered for implementation as potentially cost-beneficial. This analysis has been added as SAMA 189. This SAMA is considered potentially cost-beneficial due to management having directed that the analysis proceed. Tables 5-1, 6-1, 7-1, 8-1, and 9-1 have been updated to include SAMA 189. These updated tables are included at the end of this enclosure.

In addition to these specific flooding SAMA items, numerous SAMA items generically address loss of equipment impacted by floods in the flood zones listed in Enclosure 2, Table 2.

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

5. RAI 6.c

A new SBO value of 7.85E-07 compared to the earlier (and repeated value in the response to 1.a) of 4.71E-06 is given. Neither is consistent with that inferred from SAMA 2 Case NOSBO of 2.0E-06 (12% of 1.66E-05). The elimination of SBO sequences from the SAMA model resulting from Case NOSBO should have the same percent reduction in CDF as the SBO contribution to the total SAMA model CDF. If the SBO of 7.85E-07 is correct this is 4.73 % compared to the Case 2 result of 12.1%. Provide an explanation of why the Case NOSBO reduction in CDF is different from the correct SBO contribution to the total CDF.

Callaway Response

The original case NOSBO (2.0E-06/yr) considered only failures of the diesel generators. The case did not consider failure of the diesel generators due to support systems. This caused Case NOSBO to underestimate the potential benefit of elimination of all EDG failures. However, this case also did not consider recovery of AC power from the Alternate Emergency Power System (AEPS) given failure of the onsite diesel generators. Thus, this case represented failures of the EDGs and sequences initially recovered by power from AEPS. In a large percentage of the cases loss of onsite AC power is recovered through the AEPS, and so this had an appreciable impact on the results. The SBO related CDF of 7.85E-07/yr represents failure of the EDGs, including those from EDG support systems, without sequences where power is recovered from AEPS.

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

6. RAI 7.b

The revised response indicated that the evaluation of SAMA 186, to evaluate procedures to provide fire water to the ESW system, was changed from SW02 (no failure of ESW pumps) to FWCCW (add fire water as a backup source of cooling to the CCW heat exchangers) and resulted in a decrease in benefit from $635K to $1K). It would appear that SW02 better represents the benefit of this SAMA. Justify the selection of Case FWCCW.

Callaway Response

Case SW02 applies to all loads supplied by ESW, including the EDGs, not just the CCW heat exchangers. Emergency procedures are already in place to provide backup cooling to the EDGs using onsite fire trucks in the event that ESW cooling is lost. Case FWCCW evaluates the specific benefit of providing fire water for cooling only the CCW system heat exchangers. This is because SAMA 186 was intended to evaluate providing backup cooling to only the CCW heat exchanger loads.

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

7. RAI 1.a

i. The SBO value given of 4.71E-6 is different from that given in the response to 6.c of 7.85E-07, which states that the earlier value in incorrect. Provide the correct value for the frequency of total loss of AC power to the station. (See also the question concerning RAI 6.c above.)

ii. In the last sentence of the response, clarify whether or not the internal flood induced ATWS and SBO sequences are included in the ATWS (3.14E-7) and SBO (4.71 E-6) values quoted earlier in the response.

Callaway Response

i. The 4.71E-6/yr value included in the response to 1.a included sequences where AC power was recovered from the Alternate Emergency Power System (AEPS). The correct CDF value for total loss of AC power is 7.85E-07/yr.

ii. The frequencies of the internal flood induced ATWS and SBO sequences are included in the total internal flood CDF but are not included in the ATWS (3.14E-7) and SBO (7.85E-07) values.

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

8. RAI 6.d

Case FW02 eliminates failure of all feedwater (FW) check valves and had a CDF reduction of 5.5 percent. Common cause (CC) failure of the 4 main feedwater (MFW) check valves (AEV 120 -123) is listed along with failures of individual valves. Not listed is CC failure of 4 check valves (AEV 124 -127) from motor-driven auxiliary feedwater (MDAFW). Results of the importance analysis appear to indicate that this later failure was included in this case since it gives the 5.5 percent results. Clarify this information.

Callaway Response

Case FW02 included the individual and common cause failures of valves AEV 124-127 in addition to AEV 120-123.

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

9. RAI 6.g

The response states that:

> "For SAMAs 1, 2, and 5 in addition to the TDAFW pump dependency, loss of DC impacts the availability of instrumentation. Emergency Coordinator Supplemental Guidelines exist for the use of portable generators to provide backup power on extended SBO events. This backup portable power is not credited in the PRA."

It is not clear that the availability of this backup source of power and these guidelines would reduce the benefit of SAMA 5, DC bus cross-ties, revised to include the impact on instrumentation, to such an extent that this SAMA would not be cost-beneficial. Provide a discussion of the impact on the benefit for SAMA 5 of including the mitigation of the loss of DC instrumentation and a further justification for the evaluation of SAMA 5.

Callaway Response

The instrumentation powered by DC power is not directly modeled in the PRA. The procedural guidance in the Emergency Coordinator supplemental guidelines provides for installation of a portable generator to provide power to the battery charges. This provides a greater benefit than a cross-tie to another battery. A battery cross-tie only extends the availability of the DC bus until the second battery depletes. Use of a portable generator provides DC power availability as long as fuel is available for the generator. Callaway is currently developing additional guidance on the prolonged use of portable generators as part of the post Fukushima response. Use of the generator provides a greater benefit in prolonged SBO conditions that would deplete both the primary and the cross-tied battery.

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

10. RAI 6.q

Relative to RCP seal modeling and a SAMA to use improved seals, Case RCPLOCA gives a 5.5% reduction in CDF for SAMAs 55, 56 and 58. This seems low compared to that for other plants and it should be different for both SAMAs 55 which includes a dedicated diesel and therefore mitigates RCP seal LOCAs for an SBO and SAMA 58 which is for new improved seals which should also be beneficial for SBOs then for SAMA 56 which doesn't mitigate against an SBO. The response to RAI 6.q says this case eliminates all RCP seal LOCA events that are caused by failure of seal cooling and injection except those which occur as a result of a support system initiating event such as loss of CCW. The Loss of CCW and Loss of SW add up to 1.4% of the CDF. Is mitigation of RCP seal failure due loss of AC power (SBO) considered in the case? If not, justify this approach and assess the impact on the benefit of these SAMAs.

Callaway Response

The existence of the AEPS and the non-safety auxiliary feedwater pump reduced the risk associated with RCP seal failures. The additional AC power source and cooling ability provided by these modifications already reduce the probability of RCP seal failure and thus the relative reduction in overall risk due to elimination of seal LOCAs is not as significant as it is for plants that do not have these modifications installed.

In addition, the modeling of case RCPLOCA was examined in more detail. It was determined that this case did not include those RCP seal LOCA events that were hard coded in the event tree logic. The original case included RCP seal failures due to LOSP and SBO, but did not include seal failures due to loss of CCW or loss of all service water initiating events. No re-evaluation of this case was performed since Callaway is scheduled to install the SHIELD™ (no-leakage) RCP seals in RF19, Spring 2013, which will address a large percentage of the risk due to failure of RCP seals. In addition, the risk profile will be so significantly changed that it is not warranted to evaluate any further changes until the PRA modeling for the SHIELD™ seals is completed following RF19.

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

11. RAI Table 7-1

A number of the percent reductions in offsite dose risk in Table 7-1 are given as 0.00%. Does this mean that there is no reduction (i.e. zero) or that it is less than 0.005%? For several cases where 0.00% is given we believe that 0.00% is in error. Please provide the necessary corrections.

Callaway Response

All values for offsite dose reduction that are shown in the Table 7-1 as 0.00% are actually less than 0.005%; the rounding to two decimal places causes them to be displayed as 0.00%

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

12. RAI 5.d

The Oct. 18 revised response to this RAI indicated that automating the initiation of CCW flow to the RHR heat exchangers was now considered cost-beneficial with a 95th percentile benefit of $132K and a cost of $200K. Explain.

Callaway Response

During the expert panel discussion of this item, it was noted that Wolf Creek had implemented this modification and felt it to be beneficial. Even though the estimated cost was greater than the calculated benefit, Callaway management believes it to be beneficial in areas outside the SAMA and thus close enough to be considered potentially cost beneficial.

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

13. RAI 6.j

The response provides a description of SAMA Case LOCA 12 used to evaluate SAMAs 25, 26, and 39 which include passive or independently powered injection systems. The calculated benefit does not include that associated with loss of AC power. This would appear to be non-conservative for at least those SAMAs which do not rely on AC power. Discuss the impact of this non-conservatism.

Callaway Response

The original LOCA12 case considered only the failures of the HPI and charging pumps and did not consider the loss of AC power which would be mitigated by SAMA items which provided independent AC power. This case was revised to modify the fault trees for the HPI pumps and charging pumps to remove the dependencies on AC power, room cooling, and cooling water from those pumps. The revised case results in a 22.61% reduction in Offsite Economic Cost Risk (OECR). With a benefit of $616K and a 95% CDF benefit of $1.3M, SAMAs 25, 26, and 39 are still considered not cost-beneficial.

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

14. RAI 7.a

i. The discussion of Wolf Creek SAMAs 1 and 14 indicate that the AEPS has a spare breaker that could be used to supply the loads in these SAMAs. Our understanding is that credit for the AEPS to supply plant loads is already included in the Callaway PRA and thus what is included in new Callaway SAMAs 187 and 188 and the resulting benefit is not clear. The analysis cases used to evaluate these SAMAs (SBOMOD and SBOMOD2) both reduce the SBO frequency due to the benefit of the added availability of AC power to certain equipment. Depending on the function of the AEPS and the definition of SBO, it is possible that if credit for the AEPS is already given it must have failed in order for there to be an SBO. Explain the credit for AEPS, the description of these SAMAs and the benefit calculation.

ii. In the discussion of Wolf Creek SAMA 3, Case 4KV, used to evaluate the benefit of revised SAMA 11 (to prepare procedures for using existing equipment to cross-tie 4kV busses), is described as resolving SBO sequences assuming a 0.05 failure rate for the cross-tie then removing this failure event from cutsets involving failure of both emergency diesel generators. Exactly what this accomplished is not clear since all SBO sequences must involve failure of both emergency diesel generators (EDGs). Clarify this information.

Callaway Response

i. The PRA contains modeling for AEPS to supply those plant loads that are capable of obtaining power from AEPS. Not all plant equipment is able to obtain power from AEPS. Implementing these SAMAs by the installation of an additional diesel generator were shown to not be cost beneficial. Plant personnel proposed using the spare AEPS supply circuit breaker as a lower cost alternative of accomplishing a similar function. The use of the spare AEPS supply circuit breaker is considered to be potentially cost beneficial.

ii. This SAMA case was revised. This case first generated a fault tree reflecting loss of offsite power conditions along with the major component failure combinations that would fail both EDGs or both ESW trains. This fault tree was quantified and the resultant cutsets were removed from the total internal events core damage, LERF, and Late release cutset equations. The resulting files included those core damage cutsets where consideration of an AC bus cross-tie might reasonably provide some benefit.

The total internal events core damage frequency is 1.655E-05/yr. Removal of loss of offsite power cutsets where both EDGs or both ESW trains fail results in a core damage frequency of 1.264E-05/yr.
It was assumed that an AC bus cross-tie would have a failure probability on the order of 5.0E-02. This factor was applied to all remaining cutsets which included failure of an EDG. This resulted in a final core damage frequency of 1.225E-05/yr.

The benefit due to addition on an AC bus cross-tie would therefore be approximately 3.9E-07/yr (1.264E-05 – 1.225E-05). This equates to a benefit of $75K with a 95%

uncertainty benefit of $159K. Based on Wolf Creek's estimated implementation cost of $330K, installation of an AC power cross-tie would not be cost beneficial.

Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
1	Provide additional DC battery capacity.	Extended DC power availability during an SBO station blackout (SBO).	AC/DC	1
2	Replace lead-acid batteries with fuel cells.	Extended DC power availability during an SBO.	AC/DC	1
3	Add additional battery charger or portable, diesel-driven battery charger to existing DC system.	Improved availability of DC power system.	AC/DC	1
4	Improve DC bus load shedding.	Extended DC power availability during an SBO.	AC/DC	1
5	Provide DC bus cross-ties.	Improved availability of DC power system.	AC/DC	1
6	Provide additional DC power to the 120/240V vital AC system.	Increased availability of the 120 V vital AC bus.	AC/DC	1
7	Add an automatic feature to transfer the 120V vital AC bus from normal to standby power.	Increased availability of the 120 V vital AC bus.	AC/DC	1
8	Increase training on response to loss of two 120V AC buses which causes inadvertent actuation signals.	Improved chances of successful response to loss of two 120V AC buses.	AC/DC	1
9	Provide an additional diesel generator.	Increased availability of on-site emergency AC power.	AC/DC	1
10	Revise procedure to allow bypass of diesel generator trips.	Extended diesel generator operation.	AC/DC	1
11	Improve 4.16-kV bus cross-tie ability.	Increased availability of on-site AC power.	AC/DC	1
12	Create AC power cross-tie capability with other unit (multi-unit site)	Increased availability of on-site AC power.	AC/DC	1
13	Install an additional, buried off-site power source.	Reduced probability of loss of off-site power.	AC/DC	1
14	Install a gas turbine generator.	Increased availability of on-site AC power.	AC/DC	1
15	Install tornado protection on gas turbine generator.	Increased availability of on-site AC power.	AC/DC	1
16	Improve uninterruptible power supplies.	Increased availability of power supplies supporting front-line equipment.	AC/DC	1
17	Create a cross-tie for diesel fuel oil (multi-unit site).	Increased diesel generator availability.	AC/DC	1
18	Develop procedures for replenishing diesel fuel oil.	Increased diesel generator availability.	AC/DC	1
19	Use fire water system as a backup source for diesel cooling.	Increased diesel generator availability.	AC/DC	1

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
20	Add a new backup source of diesel cooling.	Increased diesel generator availability.	AC/DC	1
21	Develop procedures to repair or replace failed 4 KV breakers.	Increased probability of recovery from failure of breakers that transfer 4.16 kV non-emergency buses from unit station service transformers.	AC/DC	1
22	In training, emphasize steps in recovery of off-site power after an SBO.	Reduced human error probability during off-site power recovery.	AC/DC	1
23	Develop a severe weather conditions procedure.	Improved off-site power recovery following external weather-related events.	AC/DC	1
24	Bury off-site power lines.	Improved off-site power reliability during severe weather.	AC/DC	1
25	Install an independent active or passive high pressure injection system.	Improved prevention of core melt sequences.	Core Cooling	1
26	Provide an additional high pressure injection pump with independent diesel.	Reduced frequency of core melt from small LOCA and SBO sequences.	Core Cooling	1
27	Revise procedure to allow operators to inhibit automatic vessel depressurization in non-ATWS scenarios.	Extended HPCI and RCIC operation.	Core Cooling	1
28	Add a diverse low pressure injection system.	Improved injection capability.	Core Cooling	1
29	Provide capability for alternate injection via diesel-driven fire pump.	Improved injection capability.	Core Cooling	1
30	Improve ECCS suction strainers.	Enhanced reliability of ECCS suction.	Core Cooling	1
31	Add the ability to manually align emergency core cooling system recirculation.	Enhanced reliability of ECCS suction.	Core Cooling	1
32	Add the ability to automatically align emergency core cooling system to recirculation mode upon refueling water storage tank depletion.	Enhanced reliability of ECCS suction.	Core Cooling	1
33	Provide hardware and procedure to refill the reactor water storage tank once it reaches a specified low level.	Extended reactor water storage tank capacity in the event of a steam generator tube rupture (or other LOCAs challenging RWST capacity).	Core Cooling	1

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
34	Provide an in-containment reactor water storage tank.	Continuous source of water to the safety injection pumps during a LOCA event, since water released from a breach of the primary system collects in the in-containment reactor water storage tank, and thereby eliminates the need to realign the safety injection pumps for long-term post-LOCA recirculation.	Core Cooling	1
35	Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	Extended reactor water storage tank capacity.	Core Cooling	1
36	Emphasize timely recirculation alignment in operator training.	Reduced human error probability associated with recirculation failure.	Core Cooling	1
37	Upgrade the chemical and volume control system to mitigate small LOCAs.	For a plant like the Westinghouse AP600, where the chemical and volume control system cannot mitigate a small LOCA, an upgrade would decrease the frequency of core damage.	Core Cooling	1
38	Change the in-containment reactor water storage tank suction from four check valves to two check and two air-operated valves.	Reduced common mode failure of injection paths.	Core Cooling	1
39	Replace two of the four electric safety injection pumps with diesel-powered pumps.	Reduced common cause failure of the safety injection system. This SAMA was originally intended for the Westinghouse-CE System 80+, which has four trains of safety injection. However, the intent of this SAMA is to provide diversity within the high- and l	Core Cooling	1
40	Provide capability for remote, manual operation of secondary side pilot-operated relief valves in a station blackout.	Improved chance of successful operation during station blackout events in which high area temperatures may be encountered (no ventilation to main steam areas).	Core Cooling	1
41	Create a reactor coolant depressurization system.	Allows low pressure emergency core cooling system injection in the event of small LOCA and high-pressure safety injection failure.	Core Cooling	1
42	Make procedure changes for reactor coolant system depressurization.	Allows low pressure emergency core cooling system injection in the event of small LOCA and high-pressure safety injection failure.	Core Cooling	1
43	Add redundant DC control power for SW pumps.	Increased availability of SW.	Cooling Water	1

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
44	Replace ECCS pump motors with air-cooled motors.	Elimination of ECCS dependency on component cooling system.	Cooling Water	1
45	Enhance procedural guidance for use of cross-tied component cooling or service water pumps.	Reduced frequency of loss of component cooling water and service water.	Cooling Water	1
46	Add a service water pump.	Increased availability of cooling water.	Cooling Water	1
47	Enhance the screen wash system.	Reduced potential for loss of SW due to clogging of screens.	Cooling Water	1
48	Cap downstream piping of normally closed component cooling water drain and vent valves.	Reduced frequency of loss of component cooling water initiating events, some of which can be attributed to catastrophic failure of one of the many single isolation valves.	Cooling Water	1
49	Enhance loss of component cooling water (or loss of service water) procedures to facilitate stopping the reactor coolant pumps.	Reduced potential for reactor coolant pump seal damage due to pump bearing failure.	Cooling Water	1
50	Enhance loss of component cooling water procedure to underscore the desirability of cooling down the reactor coolant system prior to seal LOCA.	Reduced probability of reactor coolant pump seal failure.	Cooling Water	1
51	Additional training on loss of component cooling water.	Improved success of operator actions after a loss of component cooling water.	Cooling Water	1
52	Provide hardware connections to allow another essential raw cooling water system to cool charging pump seals.	Reduced effect of loss of component cooling water by providing a means to maintain the charging pump seal injection following a loss of normal cooling water.	Cooling Water	1
53	On loss of essential raw cooling water, proceduralize shedding component cooling water loads to extend the component cooling water heat-up time.	Increased time before loss of component cooling water (and reactor coolant pump seal failure) during loss of essential raw cooling water sequences.	Cooling Water	1
54	Increase charging pump lube oil capacity.	Increased time before charging pump failure due to lube oil overheating in loss of cooling water sequences.	Cooling Water	1
55	Install an independent reactor coolant pump seal injection system, with dedicated diesel.	Reduced frequency of core damage from loss of component cooling water, service water, or station blackout.	Cooling Water	1

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
56	Install an independent reactor coolant pump seal injection system, without dedicated diesel.	Reduced frequency of core damage from loss of component cooling water or service water, but not a station blackout.	Cooling Water	1
57	Use existing hydro test pump for reactor coolant pump seal injection.	Reduced frequency of core damage from loss of component cooling water or service water, but not a station blackout, unless an alternate power source is used.	Cooling Water	1
58	Install improved reactor coolant pump seals.	Reduced likelihood of reactor coolant pump seal LOCA.	Cooling Water	1
59	Install an additional component cooling water pump.	Reduced likelihood of loss of component cooling water leading to a reactor coolant pump seal LOCA.	Cooling Water	1
60	Prevent makeup pump flow diversion through the relief valves.	Reduced frequency of loss of reactor coolant pump seal cooling if spurious high pressure injection relief valve opening creates a flow diversion large enough to prevent reactor coolant pump seal injection.	Cooling Water	1
61	Change procedures to isolate reactor coolant pump seal return flow on loss of component cooling water, and provide (or enhance) guidance on loss of injection during seal LOCA.	Reduced frequency of core damage due to loss of seal cooling.	Cooling Water	1
62	Implement procedures to stagger high pressure safety injection pump use after a loss of service water.	Extended high pressure injection prior to overheating following a loss of service water.	Cooling Water	1
fa63	Use fire prevention system pumps as a backup seal injection and high pressure makeup source.	Reduced frequency of reactor coolant pump seal LOCA.	Cooling Water	1
64	Implement procedure and hardware modifications to allow manual alignment of the fire water system to the component cooling water system, or install a component cooling water header cross-tie.	Improved ability to cool residual heat removal heat exchangers.	Cooling Water	1
65	Install a digital feed water upgrade.	Reduced chance of loss of main feed water following a plant trip.	Feedwater/Condensate	1
66	Create ability for emergency connection of existing or new water sources to feedwater and condensate systems.	Increased availability of feedwater.	Feedwater/Condensate	1
67	Install an independent diesel for the condensate storage tank makeup pumps.	Extended inventory in CST during an SBO.	Feedwater/Condensate	1

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
68	Add a motor-driven feedwater pump.	Increased availability of feedwater.	Feedwater/Condensate	1
69	Install manual isolation valves around auxiliary feedwater turbine-driven steam admission valves.	Reduced dual turbine-driven pump maintenance unavailability.	Feedwater/Condensate	1
70	Install accumulators for turbine-driven auxiliary feedwater pump flow control valves.	Eliminates the need for local manual action to align nitrogen bottles for control air following a loss of off-site power.	Feedwater/Condensate	1
71	Install a new condensate storage tank (auxiliary feedwater storage tank).	Increased availability of the auxiliary feedwater system.	Feedwater/Condensate	1
72	Modify the turbine-driven auxiliary feedwater pump to be self-cooled.	Improved success probability during a station blackout.	Feedwater/Condensate	1
73	Proceduralize local manual operation of auxiliary feedwater system when control power is lost.	Extended auxiliary feedwater availability during a station blackout. Also provides a success path should auxiliary feedwater control power be lost in non-station blackout sequences.	Feedwater/Condensate	1
74	Provide hookup for portable generators to power the turbine-driven auxiliary feedwater pump after station batteries are depleted.	Extended auxiliary feedwater availability.	Feedwater/Condensate	1
75	Use fire water system as a backup for steam generator inventory.	Increased availability of steam generator water supply.	Feedwater/Condensate	1
76	Change failure position of condenser makeup valve if the condenser makeup valve fails open on loss of air or power.	Allows greater inventory for the auxiliary feedwater pumps by preventing condensate storage tank flow diversion to the condenser.	Feedwater/Condensate	1
77	Provide a passive, secondary-side heat-rejection loop consisting of a condenser and heat sink.	Reduced potential for core damage due to loss-of-feedwater events.	Feedwater/Condensate	1
78	Modify the startup feedwater pump so that it can be used as a backup to the emergency feedwater system, including during a station blackout scenario.	Increased reliability of decay heat removal.	Feedwater/Condensate	1
79	Replace existing pilot-operated relief valves with larger ones, such that only one is required for successful feed and bleed.	Increased probability of successful feed and bleed.	Feedwater/Condensate	1

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
80	Provide a redundant train or means of ventilation.	Increased availability of components dependent on room cooling.	HVAC	1
81	Add a diesel building high temperature alarm or redundant louver and thermostat.	Improved diagnosis of a loss of diesel building HVAC.	HVAC	1
82	Stage backup fans in switchgear rooms.	Increased availability of ventilation in the event of a loss of switchgear ventilation.	HVAC	1
83	Add a switchgear room high temperature alarm.	Improved diagnosis of a loss of switchgear HVAC.	HVAC	1
84	Create ability to switch emergency feedwater room fan power supply to station batteries in a station blackout.	Continued fan operation in a station blackout.	HVAC	1
85	Provide cross-unit connection of uninterruptible compressed air supply.	Increased ability to vent containment using the hardened vent.	IA/Nitrogen	1
86	Modify procedure to provide ability to align diesel power to more air compressors.	Increased availability of instrument air after a LOOP.	IA/Nitrogen	1
87	Replace service and instrument air compressors with more reliable compressors which have self-contained air cooling by shaft driven fans.	Elimination of instrument air system dependence on service water cooling.	IA/Nitrogen	1
88	Install nitrogen bottles as backup gas supply for safety relief valves.	Extended SRV operation time.	IA/Nitrogen	1
89	Improve SRV and MSIV pneumatic components.	Improved availability of SRVs and MSIVs.	IA/Nitrogen	1
90	Create a reactor cavity flooding system.	Enhanced debris cool ability, reduced core concrete interaction, and increased fission product scrubbing.	Containment Phenomena	1
91	Install a passive containment spray system.	Improved containment spray capability.	Containment Phenomena	1
92	Use the fire water system as a backup source for the containment spray system.	Improved containment spray capability.	Containment Phenomena	1
93	Install an unfiltered, hardened containment vent.	Increased decay heat removal capability for non-ATWS events, without scrubbing released fission products.	Containment Phenomena	1
94	Install a filtered containment vent to remove decay heat. Option 1: Gravel Bed Filter; Option 2: Multiple Venturi Scrubber	Increased decay heat removal capability for non-ATWS events, with scrubbing of released fission products.	Containment Phenomena	1

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
95	Enhance fire protection system and standby gas treatment system hardware and procedures.	Improved fission product scrubbing in severe accidents.	Containment Phenomena	1
96	Provide post-accident containment inerting capability.	Reduced likelihood of hydrogen and carbon monoxide gas combustion.	Containment Phenomena	1
97	Create a large concrete crucible with heat removal potential to contain molten core debris.	Increased cooling and containment of molten core debris. Molten core debris escaping from the vessel is contained within the crucible and a water cooling mechanism cools the molten core in the crucible, preventing melt-through of the base mat.	Containment Phenomena	1
98	Create a core melt source reduction system.	Increased cooling and containment of molten core debris. Refractory material would be placed underneath the reactor vessel such that a molten core falling on the material would melt and combine with the material. Subsequent spreading and heat removal from the vitrified compound would be facilitated, and concrete attack would not occur.	Containment Phenomena	1
99	Strengthen primary/secondary containment (e.g., add ribbing to containment shell).	Reduced probability of containment over-pressurization.	Containment Phenomena	1
100	Increase depth of the concrete base mat or use an alternate concrete material to ensure melt-through does not occur.	Reduced probability of base mat melt-through.	Containment Phenomena	1
101	Provide a reactor vessel exterior cooling system.	Increased potential to cool a molten core before it causes vessel failure, by submerging the lower head in water.	Containment Phenomena	1
102	Construct a building to be connected to primary/secondary containment and maintained at a vacuum.	Reduced probability of containment over-pressurization.	Containment Phenomena	1
103	Institute simulator training for severe accident scenarios.	Improved arrest of core melt progress and prevention of containment failure.	Containment Phenomena	1
104	Improve leak detection procedures.	Increased piping surveillance to identify leaks prior to complete failure. Improved leak detection would reduce LOCA frequency.	Containment Phenomena	1
105	Delay containment spray actuation after a large LOCA.	Extended reactor water storage tank availability.	Containment Phenomena	1

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
106	Install automatic containment spray pump header throttle valves.	Extended time over which water remains in the reactor water storage tank, when full containment spray flow is not needed.	Containment Phenomena	1
107	Install a redundant containment spray system.	Increased containment heat removal ability.	Containment Phenomena	1
108	Install an independent power supply to the hydrogen control system using either new batteries, a non-safety grade portable generator, existing station batteries, or existing AC/DC independent power supplies, such as the security system diesel.	Reduced hydrogen detonation potential.	Containment Phenomena	1
109	Install a passive hydrogen control system.	Reduced hydrogen detonation potential.	Containment Phenomena	1
110	Erect a barrier that would provide enhanced protection of the containment walls (shell) from ejected core debris following a core melt scenario at high pressure.	Reduced probability of containment failure.	Containment Phenomena	1
111	Install additional pressure or leak monitoring instruments for detection of ISLOCAs.	Reduced ISLOCA frequency.	Containment Bypass	1
112	Add redundant and diverse limit switches to each containment isolation valve.	Reduced frequency of containment isolation failure and ISLOCAs.	Containment Bypass	1
113	Increase leak testing of valves in ISLOCA paths.	Reduced ISLOCA frequency.	Containment Bypass	1
114	Install self-actuating containment isolation valves.	Reduced frequency of isolation failure.	Containment Bypass	1
115	Locate residual heat removal (RHR) inside containment	Reduced frequency of ISLOCA outside containment.	Containment Bypass	1
116	Ensure ISLOCA releases are scrubbed. One method is to plug drains in potential break areas so that break point will be covered with water.	Scrubbed ISLOCA releases.	Containment Bypass	1

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
117	Revise EOPs to improve ISLOCA identification.	Increased likelihood that LOCAs outside containment are identified as such. A plant had a scenario in which an RHR ISLOCA could direct initial leakage back to the pressurizer relief tank, giving indication that the LOCA was inside containment.	Containment Bypass	1
118	Improve operator training on ISLOCA coping.	Decreased ISLOCA consequences.	Containment Bypass	1
119	Institute a maintenance practice to perform a 100% inspection of steam generator tubes during each refueling outage.	Reduced frequency of steam generator tube ruptures.	Containment Bypass	1
120	Replace steam generators with a new design.	Reduced frequency of steam generator tube ruptures.	Containment Bypass	1
121	Increase the pressure capacity of the secondary side so that a steam generator tube rupture would not cause the relief valves to lift.	Eliminates release pathway to the environment following a steam generator tube rupture.	Containment Bypass	1
122	Install a redundant spray system to depressurize the primary system during a steam generator tube rupture	Enhanced depressurization capabilities during steam generator tube rupture.	Containment Bypass	1
123	Proceduralize use of pressurizer vent valves during steam generator tube rupture sequences.	Backup method to using pressurizer sprays to reduce primary system pressure following a steam generator tube rupture.	Containment Bypass	1
124	Provide improved instrumentation to detect steam generator tube ruptures, such as Nitrogen-16 monitors).	Improved mitigation of steam generator tube ruptures.	Containment Bypass	1
125	Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove most of the fission products.	Reduced consequences of a steam generator tube rupture.	Containment Bypass	1
126	Install a highly reliable (closed loop) steam generator shell-side heat removal system that relies on natural circulation and stored water sources	Reduced consequences of a steam generator tube rupture.	Containment Bypass	1
127	Revise emergency operating procedures to direct isolation of a faulted steam generator.	Reduced consequences of a steam generator tube rupture.	Containment Bypass	1
128	Direct steam generator flooding after a steam generator tube rupture, prior to core damage.	Improved scrubbing of steam generator tube rupture releases.	Containment Bypass	1

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
129	Vent main steam safety valves in containment.	Reduced consequences of a steam generator tube rupture.	Containment Bypass	1
130	Add an independent boron injection system.	Improved availability of boron injection during ATWS.	ATWS	1
131	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS.	Improved equipment availability after an ATWS.	ATWS	1
132	Provide an additional control system for rod insertion (e.g., AMSAC).	Improved redundancy and reduced ATWS frequency.	ATWS	1
133	Install an ATWS sized filtered containment vent to remove decay heat.	Increased ability to remove reactor heat from ATWS events.	ATWS	1
134	Revise procedure to bypass MSIV isolation in turbine trip ATWS scenarios.	Affords operators more time to perform actions. Discharge of a substantial fraction of steam to the main condenser (i.e., as opposed to into the primary containment) affords the operator more time to perform actions (e.g., SLC injection, lower water level, depressurize RPV) than if the main condenser was unavailable, resulting in lower human error probabilities.	ATWS	1
135	Revise procedure to allow override of low pressure core injection during an ATWS event.	Allows immediate control of low pressure core injection. On failure of high pressure core injection and condensate, some plants direct reactor depressurization followed by five minutes of automatic low pressure core injection.	ATWS	1
136	Install motor generator set trip breakers in control room.	Reduced frequency of core damage due to an ATWS.	ATWS	1
137	Provide capability to remove power from the bus powering the control rods.	Decreased time required to insert control rods if the reactor trip breakers fail (during a loss of feedwater ATWS which has rapid pressure excursion).	ATWS	1
138	Improve inspection of rubber expansion joints on main condenser.	Reduced frequency of internal flooding due to failure of circulating water system expansion joints.	Internal Flooding	1
139	Modify swing direction of doors separating turbine building basement from areas containing safeguards equipment.	Prevents flood propagation.	Internal Flooding	1
140	Increase seismic ruggedness of plant components.	Increased availability of necessary plant equipment during and after seismic events.	Seismic Risk	1

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
141	Provide additional restraints for CO2 tanks.	Increased availability of fire protection given a seismic event.	Seismic Risk	1
142	Replace mercury switches in fire protection system.	Decreased probability of spurious fire suppression system actuation.	Fire Risk	1
143	Upgrade fire compartment barriers.	Decreased consequences of a fire.	Fire Risk	1
144	Install additional transfer and isolation switches.	Reduced number of spurious actuations during a fire.	Fire Risk	1
145	Enhance fire brigade awareness.	Decreased consequences of a fire.	Fire Risk	1
146	Enhance control of combustibles and ignition sources.	Decreased fire frequency and consequences.	Fire Risk	1
147	Install digital large break LOCA protection system.	Reduced probability of a large break LOCA (a leak before break).	Other	1
148	Enhance procedures to mitigate large break LOCA.	Reduced consequences of a large break LOCA.	Other	1
149	Install computer aided instrumentation system to assist the operator in assessing post-accident plant status.	Improved prevention of core melt sequences by making operator actions more reliable.	Other	1
150	Improve maintenance procedures.	Improved prevention of core melt sequences by increasing reliability of important equipment.	Other	1
151	Increase training and operating experience feedback to improve operator response.	Improved likelihood of success of operator actions taken in response to abnormal conditions.	Other	1
152	Develop procedures for transportation and nearby facility accidents.	Reduced consequences of transportation and nearby facility accidents.	Other	1
153	Install secondary side guard pipes up to the main steam isolation valves.	Prevents secondary side depressurization should a steam line break occur upstream of the main steam isolation valves. Also guards against or prevents consequential multiple steam generator tube ruptures following a main steam line break event.	Other	1
154	Mount or anchor the MCCs to the respective building walls.	Reduces failure probability of MCCs during an earthquake	IPEEE - Seismic	B
155	Install shear pins (or strength bolts) in the AFW pumps.	Takes up the shear load on the pump and/or driver during an earthquake.	IPEEE - Seismic	B

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
156	Mount all fire extinguishers within their UL Standard required drop height and remove hand-held fire extinguishers from Containment during normal operation.	Reduces the potential for the fire extinguishers to fall during an earthquake and potentially fracturing upon impact with the floor or another object.	IPEEE - Seismic	B
157	Identify and remove unsecured equipment near areas that contain relays that actuate, so area is kept clear.	Ensures direct access to areas such as Load Shedding and Emergency Load Sequencing (LSELS) and Engineered Safety Feature Actuation System (ESFAS) cabinets. Unsecured equipment (e.g., carts, filing cabinets, and test equipment) in these areas could result	IPEEE – Seismic	B
158	Properly position chain hoists that facilitate maintenance on pumps within pump rooms and institute a training program to ensure that the hoists are properly positioned when not in use.	Improper positioning of hoists reduces the availability due to moving during an earthquake and having chainfalls impacting pump oil bubblers or other soft targets resulting in failure of the pumps.	IPEEE – Seismic	B
159	Secure floor grating to prevent damage to sensing lines due to differential building motion.	Prevent sensing lines that pass through the grating from being damaged.	IPEEE – Seismic	B
160	Modifications to lessen impact of internal flooding path through Control Building dumbwaiter.	Lower impact of flood that propagates through the dumbwaiter	Internal Flooding	D
161	Improvements to PORV performance that will lower the probability of failure to open.	Decrease in risk due to PORV failing to open.	Core Cooling	E
162	Install a large volume EDG fuel oil tank at an elevation greater than the EDG fuel oil day tanks.	Allows transfer of EDF fuel oil to the EDG day tanks on failure of the fuel oil transfer pumps.	AC/DC	C
163	Improve feedwater check valve reliability to reduce probability of failure to open.	Lower risk due to failures in which feedwater check valves fail to open and allow feeding of the steam generators.	Cooling Water	E
164	Provide the capability to power the normal service water pumps from AEPS.	Provide backup to ESW in conditions with power only available from AEPS.	Cooling Water	D
165	Purchase or manufacture a "gagging device" that could be used to close a stuck open steam generator relief valve for a SGTR event prior to core damage.	Reduce the amount of radioactive material release to the atmosphere in a SGTR event with core damage.	SGTR	C
166	Installation of high temperature qualified RCP seal O-rings.	Lower potential for RCP seal leakage.	RCP Seal LOCA	A

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
167	Addition of procedural guidance to re-establish normal service water should essential service water fail.	Provide back-up pumps for UHS cooling.	Cooling Water	A
168	Addition of procedural guidance for running charging and safety injection pumps without component cooling water	Allow use of pumps following loss of component cooling water.	Cooling Water	A
169	Addition of procedural guidance to verify RHR pump room cooling at switchover to ECCS recirculation phase.	Verifying that support system for RHR pumps is in service to allow continued operation of RHR pumps.	HVAC	A
170	Modifications to add controls in the main control room to allow remote operation of nearby diesel generator farm and alignment/connection to the plant vital electrical busses.	Faster ability to provide power to the plant electrical busses from the offsite diesel generator farm.	AC Power	C
171	Increase the size of the RWST or otherwise improve the availability of the RWST	Ensure a supply of makeup water is available from the RWST.	Core Cooling	E
172	Addition of procedural guidance and the required hardware to enable the operators to feed one or more steam generators with a diesel driven firewater pump.	Provide a backup to turbine driven auxiliary feedwater.	Feedwater	A
173	Addition of a black start combustion turbine generator.	A redundant source of AC Power that could be used in station blackout events.	AC Power	A
174	Addition of a black-start engine-generator to provide AC Power during a station blackout	Ability to power a 125VDC battery charger and a charging pump. Powering the battery charger would permit operation of the TDAFP without recovering AC power. Powering a charging pump could provide RCP seal injection and preclude a RCP seal LOCA during a station blackout.	AC Power	A
175	Replacement of the positive displacement charging pump with a third centrifugal charging pump.	Provide another source for RCP seal cooling, RCS makeup, and pumped flow for feed and bleed.	Cooling Water	A
176	Provide control modifications to bypass feedwater isolation in order to restore main feedwater.	Allow faster and more reliable bypass of the main feedwater isolation signal in order to restore main feedwater to the steam generators should auxiliary feedwater fail.	Feedwater	A

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
177	Procedural and hardware modifications to reduce core damage risk due to internal flooding.	The IPE identified a need to form a task force to identify and evaluate potential procedural and hardware modifications aimed at reducing the risk due to internal flooding.	Flooding	A
178	Improvements to UHS cooling tower electrical room HVAC.	Improve availability or mitigate loss of HVAC.	HVAC	E
179	Modify procedures such that the water loop seals in the RCS cold legs are not cleared following core damage.	Prevents possible thermally induced steam generator tube rupture following core damage.	Containment Bypass	C
180	Install lower amperage fuses for various 14 AWG control circuits in the MCR. The majority of the modification centers around the trip circuit fuses on NB, NG, PA, PB, and PG system breakers.	Reduced fire risk.	Fire Risk	F
181	Install redundant fuses and isolation switches for MCR evacuation procedure OTO-ZZ-00001.	Reduced fire risk.	Fire Risk	F
182	To protect against multiple spurious operation scenarios, cable runs will be changed to run a single wire in a protected metal jacket such that spurious valve opening due to a hot short affecting the valve control circuit is eliminated for the fire area. This modification will be implemented in multiple fire areas.	Reduced fire risk.	Fire Risk	F
183	Quick response sprinkler heads in cable chases A-11, C-30, and C-31 will be modified to be in accordance with the applicable requirements of NFPA 13-1976 edition.	Reduced fire risk.	Fire Risk	F
184	Improvements in the reliability of the Steam Line Isolation automatic signal.	More reliable main steam line isolation.	Containment Isolation	E
185	Automate initiation of CCW flow to the RHR heat exchangers.	More reliable than manual initiation of flow to RRHR HX.	Cooling Water	E
186	Develop a procedure and obtain equipment to provide a temporary hookup of fire water as a replacement for ESW	Backup cooling water if ESW/SW is lost	Cooling Water	D
187	Install modification to power the normal charging pump from an existing spare breaker from the AEPS.	Another source of backup power to the NCP in cases of station blackout or loss of service water	Cooling Water	C

Table 5-1. List of SAMA Candidates.

Callaway SAMA Number	Potential Improvement	Discussion	Focus of SAMA	Source
188	Install a permanent, dedicated generator for the NCP, and a motor-driven AFW pump and battery charger to address SBO events in which the TD AFW pump is unavailable.	Another source of backup power to the NCP, DC power (pump/valve control and SG level instrumentation), and power to an AFW pump in cases of station blackout or loss of service water	Cooling Water	C
189	Perform analysis to determine if it is possible to modify current plant doors to withstand higher flood heights. Either perform modifications to install improved doors or revise flooding analysis to incorporate results that doors will withstand higher flooding heights without propagating the flood.	Reduction in risk due to internal flooding.	Internal Flooding	D

Note 1: The source references are:

- 1 NEI 05-01 (Reference 19)
- A IPE (Reference 28)
- B IPEEE (Reference 29)
- C Recent industry SAMA submittals (Wolf Creek, South Texas, Diablo Canyon, Seabrook)
- D Expert panel convened to review SAMA analysis or other plant personnel
- E PRA importance list review
- F Callaway NFPA 805 License Amendment Request

6.0 PHASE I ANALYSIS

A preliminary screening of the complete list of SAMA candidates was performed to limit the number of SAMAs for which detailed analysis in Phase II was necessary. The screening criteria used in the Phase I analysis are described below.

Screening Criterion A - Not Applicable: If a SAMA candidate did not apply to the Callaway Unit 1 plant design, it was not retained.

Screening Criterion B - Already Implemented or Intent Met: If a SAMA candidate had already been implemented at the Callaway Plant or its intended benefit already achieved by other means, it was not retained.

Screening Criterion C - Combined: If a SAMA candidate was similar in nature and could be combined with another SAMA candidate to develop a more comprehensive or plant-specific SAMA candidate, only the combined SAMA candidate was retained.

Screening Criterion D - Excessive Implementation Cost: If a SAMA required extensive changes that will obviously exceed the maximum benefit (Section 4.5), even without an implementation cost estimate, it was not retained.

Screening Criterion E - Very Low Benefit: If a SAMA from an industry document was related to a non-risk significant system for which change in reliability is known to have negligible impact on the risk profile, it was not retained. (No SAMAs were screened using this criterion.)

Table 6-1 presents the list of Phase I SAMA candidates and provides the disposition of each candidate along with the applicable screening criterion associated with each candidate. Those candidates that have not been screened by application of these criteria are evaluated further in the Phase II analysis (Section 7).

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
12	Create AC power cross-tie capability with other unit (multi-unit site)	Increased availability of on-site AC power.	Yes	A - Not Applicable	Callaway is a single unit site.
17	Create a cross-tie for diesel fuel oil (multi-unit site).	Increased diesel generator availability.	Yes	A - Not Applicable	Callaway is a single unit site.
27	Revise procedure to allow operators to inhibit automatic vessel depressurization in non-ATWS scenarios.	Extended HPCI and RCIC operation.	Yes	A - Not Applicable	BWR item.
34	Provide an in-containment reactor water storage tank.	Continuous source of water to the safety injection pumps during a LOCA event, since water released from a breach of the primary system collects in the in-containment reactor water storage tank, and thereby eliminates the need to realign the safety injection pumps for long-term post-LOCA recirculation.	Yes	A - Not Applicable	Not applicable for existing designs. Insufficient room inside primary containment.
35	Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	Extended reactor water storage tank capacity.	Yes	A - Not Applicable	Per the Callaway safety analysis, this is an undesirable action. The Callaway safety analysis and design calls for injection of the RWST to inside the containment as soon as possible.
38	Change the in-containment reactor water storage tank suction from four check valves to two check and two air-operated valves.	Reduced common mode failure of injection paths.	Yes	A - Not Applicable	Callaway does not have an in-containment RWST with this valve arrangement.
47	Enhance the screen wash system.	Reduced potential for loss of SW due to clogging of screens.	Yes	A - Not Applicable	Plant uses Ultimate Heat Sink pond for cooling. UHS sized for 30 days without make-up. River intake is only used for make-up to the UHS.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
52	Provide hardware connections to allow another essential raw cooling water system to cool charging pump seals.	Reduced effect of loss of component cooling water by providing a means to maintain the charging pump seal injection following a loss of normal cooling water.	Yes	A - Not Applicable	Charging pump seals do not require external cooling, they are cooled by the process fluid.
57	Use existing hydro test pump for reactor coolant pump seal injection.	Reduced frequency of core damage from loss of component cooling water or service water, but not a station blackout, unless an alternate power source is used.	Yes	A - Not Applicable	Callaway does not have a permanently installed hydro test pump. Timing considerations prevent credit for hookup of temporary pump.
63	Use fire prevention system pumps as a backup seal injection and high pressure makeup source.	Reduced frequency of reactor coolant pump seal LOCA.	Yes	A - Not Applicable	Existing fire protection system pumps do not have sufficient discharge head to use as high pressure makeup source.
69	Install manual isolation valves around auxiliary feedwater turbine-driven steam admission valves.	Reduced dual turbine-driven pump maintenance unavailability.	Yes	A - Not Applicable	Callaway does not have dual turbine AFW pump.
85	Provide cross-unit connection of uninterruptible compressed air supply.	Increased ability to vent containment using the hardened vent.	Yes	A - Not Applicable	N/A, single unit.
95	Enhance fire protection system and standby gas treatment system hardware and procedures.	Improved fission product scrubbing in severe accidents.	Yes	A - Not Applicable	Standby gas treatment system is BWR item.
105	Delay containment spray actuation after a large LOCA.	Extended reactor water storage tank availability.	Yes	A - Not Applicable	Per the Callaway safety analysis, this is an undesirable action. The Callaway safety analysis and design calls for injection of the RWST to inside the containment as soon as possible.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
106	Install automatic containment spray pump header throttle valves.	Extended time over which water remains in the reactor water storage tank, when full containment spray flow is not needed.	Yes	A - Not Applicable	Per the Callaway safety analysis, this is an undesirable action. The Callaway safety analysis and design calls for injection of the RWST to inside the containment as soon as possible.
134	Revise procedure to bypass MSIV isolation in turbine trip ATWS scenarios.	Affords operators more time to perform actions. Discharge of a substantial fraction of steam to the main condenser (i.e., as opposed to into the primary containment) affords the operator more time to perform actions (e.g., SLC injection, lower water level, depressurize RPV) than if the main condenser was unavailable, resulting in lower human error probabilities.	Yes	A - Not Applicable	Specific to BWRs.
135	Revise procedure to allow override of low pressure core injection during an ATWS event.	Allows immediate control of low pressure core injection. On failure of high pressure core injection and condensate, some plants direct reactor depressurization followed by five minutes of automatic low pressure core injection.	Yes	A - Not Applicable	Based on description, this is a BWR item.
138	Improve inspection of rubber expansion joints on main condenser.	Reduced frequency of internal flooding due to failure of circulating water system expansion joints.	Yes	A - Not Applicable	No risk significant flooding sources identified in the turbine building.
139	Modify swing direction of doors separating turbine building basement from areas containing safeguards equipment.	Prevents flood propagation.	Yes	A - Not Applicable	Flooding analysis did not indicate any flooding issues related to the direction of door swing.
142	Replace mercury switches in fire protection system.	Decreased probability of spurious fire suppression system actuation.	Yes	A - Not Applicable	No mercury switches in the fire protection system.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
143	Upgrade fire compartment barriers.	Decreased consequences of a fire.	Yes	A - Not Applicable	Fire analysis did not identify any issues related to fire barriers. NFPA 805 Fire Protection Program is in progress, any issues identified by that project will be handled by the NFPA 805 program.
152	Develop procedures for transportation and nearby facility accidents.	Reduced consequences of transportation and nearby facility accidents.	Yes	A - Not Applicable	IPEEE determined that there are no transportation routes or nearby facilities that could cause concern.
165	Purchase or manufacture a "gagging device" that could be used to close a stuck open steam generator relief valve for a SGTR event prior to core damage.	Reduce the amount of radioactive material release to the atmosphere in a SGTR event with core damage.	Yes	A - Not Applicable	Callaway does not have the ability to isolate the steam generator from the RCS loop. The amount of force required to close a stuck open atmospheric steam dump valve would likely not be successful and would result in further damage to the valve.
3	Add additional battery charger or portable, diesel-driven battery charger to existing DC system.	Improved availability of DC power system.	Yes	B - Intent Met	Current configuration is two spare battery chargers for the instrument buses. The spare can carry one bus. One feeds A/B, the other feeds C/D trains. Also Emergency Coordinator Supplemental Guidelines, Attachment N, "Temporary Power to NK Swing Charger
4	Improve DC bus load shedding.	Extended DC power availability during an SBO.	Yes	B - Intent Met	DC load shedding is conducted.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
6	Provide additional DC power to the 120/240V vital AC system.	Increased availability of the 120 V vital AC bus.	Yes	B - Intent Met	Procedures in place to provide temporary power to DC Chargers which can power vital AC system.
7	Add an automatic feature to transfer the 120V vital AC bus from normal to standby power.	Increased availability of the 120 V vital AC bus.	Yes	B - Intent Met	On loss of DC or inverter, the UPS static switch automatically transfers to AC power through a constant voltage transformer. An additional backup AC source is available, but must be closed manually.
8	Increase training on response to loss of two 120V AC buses which causes inadvertent actuation signals.	Improved chances of successful response to loss of two 120V AC buses.	Yes	B - Intent Met	Typical response training in place.
9	Provide an additional diesel generator.	Increased availability of on-site emergency AC power.	Yes	B - Intent Met	Alternate Emergency Power System installed.
10	Revise procedure to allow bypass of diesel generator trips.	Extended diesel generator operation.	Yes	B - Intent Met	Bypass of non-vital diesel generator trips were in original design for Callaway.
13	Install an additional, buried off-site power source.	Reduced probability of loss of off-site power.	Yes	B - Intent Met	AEPS installed with buried power lines.
14	Install a gas turbine generator.	Increased availability of on-site AC power.	Yes	B - Intent Met	Alternate Emergency Power System installed.
16	Improve uninterruptible power supplies.	Increased availability of power supplies supporting front-line equipment.	Yes	B - Intent Met	Replaced to add static switch and upgrade to newer design.
18	Develop procedures for replenishing diesel fuel oil.	Increased diesel generator availability.	Yes	B - Intent Met	EOP Addenda direct ordering fuel oil.
19	Use fire water system as a backup source for diesel cooling.	Increased diesel generator availability.	Yes	B - Intent Met	Procedures exist for cooling EDG with fire water.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
20	Add a new backup source of diesel cooling.	Increased diesel generator availability.	Yes	B - Intent Met	Procedure exists for backup diesel cooling.
21	Develop procedures to repair or replace failed 4 KV breakers.	Increased probability of recovery from failure of breakers that transfer 4.16 kV non-emergency buses from unit station service transformers.	Yes	B - Intent Met	Spares exist and procedures exist.
22	In training, emphasize steps in recovery of off-site power after an SBO.	Reduced human error probability during off-site power recovery.	Yes	B - Intent Met	Recovery stressed in training.
23	Develop a severe weather conditions procedure.	Improved off-site power recovery following external weather-related events.	Yes	B - Intent Met	Severe weather condition procedure in place.
30	Improve ECCS suction strainers.	Enhanced reliability of ECCS suction.	Yes	B - Intent Met	Callaway has implemented a containment sump modification that now uses state-of-the-art strainers to address the industry's concerns on blockage from debris. This modification occurred over two outages in 2007 and 2008.
31	Add the ability to manually align emergency core cooling system recirculation.	Enhanced reliability of ECCS suction.	Yes	B - Intent Met	Current alignment capabilities are half and half (manual/automatic).
32	Add the ability to automatically align emergency core cooling system to recirculation mode upon refueling water storage tank depletion.	Enhanced reliability of ECCS suction.	Yes	B - Intent Met	Current alignment capabilities are half and half (manual/automatic).
33	Provide hardware and procedure to refill the reactor water storage tank once it reaches a specified low level.	Extended reactor water storage tank capacity in the event of a steam generator tube rupture (or other LOCAs challenging RWST capacity).	Yes	B - Intent Met	Addressed in SAMGs and the EC Supplemental Guideline.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
36	Emphasize timely recirculation alignment in operator training.	Reduced human error probability associated with recirculation failure.	Yes	B - Intent Met	Current alignment capabilities are half and half (manual/automatic). Swap to recirculation is stressed in operator training.
37	Upgrade the chemical and volume control system to mitigate small LOCAs.	For a plant like the Westinghouse AP600, where the chemical and volume control system cannot mitigate a small LOCA, an upgrade would decrease the frequency of core damage.	Yes	B - Intent Met	CVCS system is capable of mitigating small LOCA.
40	Provide capability for remote, manual operation of secondary side pilot-operated relief valves in a station blackout.	Improved chance of successful operation during station blackout events in which high area temperatures may be encountered (no ventilation to main stream areas).	Yes	B - Intent Met	Remote Operation of Atmospheric Steam Dumps (ASDs) is possible. Equipment Operators trained and Operator Aid posted.
42	Make procedure changes for reactor coolant system depressurization.	Allows low pressure emergency core cooling system injection in the event of small LOCA and high-pressure safety injection failure.	Yes	B - Intent Met	Multiple depressurization methods are in place.
44	Replace ECCS pump motors with air-cooled motors.	Elimination of ECCS dependency on component cooling system.	Yes	B - Intent Met	Current ECCS pump motors are air-cooled. Additionally the plant OTN procedures allow for alternate trains to supply cooling.
45	Enhance procedural guidance for use of cross-tied component cooling or service water pumps.	Reduced frequency of loss of component cooling water and service water.	Yes	B - Intent Met	Can use service water as backup to ESW.
48	Cap downstream piping of normally closed component cooling water drain and vent valves.	Reduced frequency of loss of component cooling water initiating events, some of which can be attributed to catastrophic failure of one of the many single isolation valves.	Yes	B - Intent Met	Vents & drains capped.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
49	Enhance loss of component cooling water (or loss of service water) procedures to facilitate stopping the reactor coolant pumps.	Reduced potential for reactor coolant pump seal damage due to pump bearing failure.	Yes	B - Intent Met	CCW is cooled by ESW. Currently authorized to run 10 minutes.
50	Enhance loss of component cooling water procedure to underscore the desirability of cooling down the reactor coolant system prior to seal LOCA.	Reduced probability of reactor coolant pump seal failure.	Yes	B - Intent Met	Procedures include direction to cool down to minimize impact of RCP seal LOCA.
51	Additional training on loss of component cooling water.	Improved success of operator actions after a loss of component cooling water.	Yes	B - Intent Met	Training is conducted for Loss of CCW.
53	On loss of essential raw cooling water, proceduralize shedding component cooling water loads to extend the component cooling water heat-up time.	Increased time before loss of component cooling water (and reactor coolant pump seal failure) during loss of essential raw cooling water sequences.	Yes	B - Intent Met	Most non-safety loads have been removed from the system. Non-safety loop is automatically isolated on safety injection signal.
60	Prevent makeup pump flow diversion through the relief valves.	Reduced frequency of loss of reactor coolant pump seal cooling if spurious high pressure injection relief valve opening creates a flow diversion large enough to prevent reactor coolant pump seal injection.	Yes	B - Intent Met	Current configuration does not have a relief valve.
61	Change procedures to isolate reactor coolant pump seal return flow on loss of component cooling water, and provide (or enhance) guidance on loss of injection during seal LOCA.	Reduced frequency of core damage due to loss of seal cooling.	Yes	B - Intent Met	Procedure exist
62	Implement procedures to stagger high pressure safety injection pump use after a loss of service water.	Extended high pressure injection prior to overheating following a loss of service water.	Yes	B - Intent Met	Procedure currently in place to stagger use of HPSI.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
66	Create ability for emergency connection of existing or new water sources to feedwater and condensate systems.	Increased availability of feedwater.	Yes	B - Intent Met	Procedures exist.
67	Install an independent diesel for the condensate storage tank makeup pumps.	Extended inventory in CST during an SBO.	Yes	B - Intent Met	Procedures do exist for make-up to CST from fire water and for supplying fire water directly to the TDAFW pump.
68	Add a motor-driven feedwater pump.	Increased availability of feedwater.	Yes	B - Intent Met	Non-Safety Auxiliary Feedwater Pump installed.
70	Install accumulators for turbine-driven auxiliary feedwater pump flow control valves.	Eliminates the need for local manual action to align nitrogen bottles for control air following a loss of off-site power.	Yes	B - Intent Met	Currently have nitrogen accumulators.
72	Modify the turbine-driven auxiliary feedwater pump to be self-cooled.	Improved success probability during a station blackout.	Yes	B - Intent Met	Turbine-driven auxiliary feedwater pump is self-cooled.
73	Proceduralize local manual operation of auxiliary feedwater system when control power is lost.	Extended auxiliary feedwater availability during a station blackout. Also provides a success path should auxiliary feedwater control power be lost in non-station blackout sequences.	Yes	B - Intent Met	Procedures exist.
74	Provide hookup for portable generators to power the turbine-driven auxiliary feedwater pump after station batteries are depleted.	Extended auxiliary feedwater availability.	Yes	B - Intent Met	Procedures exist, hardware on site.
75	Use fire water system as a backup for steam generator inventory.	Increased availability of steam generator water supply.	Yes	B - Intent Met	Equipment staged at CST for makeup. See operator aids. Procedural guidance exists.
76	Change failure position of condenser makeup valve if the condenser makeup valve fails open on loss of air or power.	Allows greater inventory for the auxiliary feedwater pumps by preventing condensate storage tank flow diversion to the condenser.	Yes	B - Intent Met	Valve currently fails closed.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
78	Modify the startup feedwater pump so that it can be used as a backup to the emergency feedwater system, including during a station blackout scenario.	Increased reliability of decay heat removal.	Yes	B - Intent Met	Non-Safety Auxiliary Feedwater Pump gets power from Alternate Emergency Power System.
81	Add a diesel building high temperature alarm or redundant louver and thermostat.	Improved diagnosis of a loss of diesel building HVAC.	Yes	B - Intent Met	Computer points for monitoring diesel room temperatures.
82	Stage backup fans in switchgear rooms.	Increased availability of ventilation in the event of a loss of switchgear ventilation.	Yes	B - Intent Met	Procedures include instructions for opening doors to provide alternate cooling capability.
83	Add a switchgear room high temperature alarm.	Improved diagnosis of a loss of switchgear HVAC.	Yes	B - Intent Met	Plant Process Computer has alarming computer points for switchgear room temperature.
84	Create ability to switch emergency feedwater room fan power supply to station batteries in a station blackout.	Continued fan operation in a station blackout.	Yes	B - Intent Met	Procedure currently in place to switch fan power supply.
86	Modify procedure to provide ability to align diesel power to more air compressors.	Increased availability of instrument air after a LOOP.	Yes	B - Intent Met	Currently have 3 air compressors (service air). A/B compressors are powered off the emergency buses (cooled from essential service lines). Compressors are initially load shed, but procedure direct operators to override and place compressor in service.
88	Install nitrogen bottles as backup gas supply for safety relief valves.	Extended SRV operation time.	Yes	B - Intent Met	Current configuration includes nitrogen bottles as backup gas supply.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
89	Improve SRV and MSIV pneumatic components.	Improved availability of SRVs and MSIVs.	Yes	B - Intent Met	MSIV actuators changed to process fluid actuated. Modification installed to relocate Atmospheric Steam Dump valve controllers.
90	Create a reactor cavity flooding system.	Enhanced debris cool ability, reduced core concrete interaction, and increased fission product scrubbing.	Yes	B - Intent Met	Procedures exist
92	Use the fire water system as a backup source for the containment spray system.	Improved containment spray capability.	Yes	B - Intent Met	Procedures exist
101	Provide a reactor vessel exterior cooling system.	Increased potential to cool a molten core before it causes vessel failure, by submerging the lower head in water.	Yes	B - Intent Met	Procedures exist.
103	Institute simulator training for severe accident scenarios.	Improved arrest of core melt progress and prevention of containment failure.	Yes	B - Intent Met	Operators are trained on the SAMG that the operators must implement.
117	Revise EOPs to improve ISLOCA identification.	Increased likelihood that LOCAs outside containment are identified as such. A plant had a scenario in which an RHR ISLOCA could direct initial leakage back to the pressurizer relief tank, giving indication that the LOCA was inside containment.	Yes	B - Intent Met	Current EOPs address ISLOCA identification.
118	Improve operator training on ISLOCA coping.	Decreased ISLOCA consequences.	Yes	B - Intent Met	Current procedure training addresses ISLOCA identification.
120	Replace steam generators with a new design.	Reduced frequency of steam generator tube ruptures.	Yes	B - Intent Met	Replaced during the fall of 2005 (newer design) which consist of 72,000 sq. ft. per generator.
123	Proceduralize use of pressurizer vent valves during steam generator tube rupture sequences.	Backup method to using pressurizer sprays to reduce primary system pressure following a steam generator tube rupture.	Yes	B - Intent Met	Procedure currently in place.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
124	Provide improved instrumentation to detect steam generator tube ruptures, such as Nitrogen-16 monitors).	Improved mitigation of steam generator tube ruptures.	Yes	B - Intent Met	Modification installed to improve operation of N16 detectors.
127	Revise emergency operating procedures to direct isolation of a faulted steam generator.	Reduced consequences of a steam generator tube rupture.	Yes	B - Intent Met	EOP currently in place.
128	Direct steam generator flooding after a steam generator tube rupture, prior to core damage.	Improved scrubbing of steam generator tube rupture releases.	Yes	B - Intent Met	Procedures direct that steam generator level be maintained above the tubes.
132	Provide an additional control system for rod insertion (e.g., AMSAC).	Improved redundancy and reduced ATWS frequency.	Yes	B - Intent Met	Currently have AMSAC.
137	Provide capability to remove power from the bus powering the control rods.	Decreased time required to insert control rods if the reactor trip breakers fail (during a loss of feedwater ATWS which has rapid pressure excursion).	Yes	B - Intent Met	Response procedure in place.
144	Install additional transfer and isolation switches.	Reduced number of spurious actuations during a fire.	Yes	B - Intent Met	Items are identified and are being implemented as part of the 805 process. Examples include fuse and alternate feed line modifications to prevent the loss of the 4160 V buses.
145	Enhance fire brigade awareness.	Decreased consequences of a fire.	Yes	B - Intent Met	Most recent inspections and evaluations did not identify any weaknesses in this area.
146	Enhance control of combustibles and ignition sources.	Decreased fire frequency and consequences.	Yes	B - Intent Met	Procedure in place. NFPA-805 project will evaluate the needs for any additional controls.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
148	Enhance procedures to mitigate large break LOCA.	Reduced consequences of a large break LOCA.	Yes	B - Intent Met	Existing procedures meet current guidelines issued by the Owner's Group.
149	Install computer aided instrumentation system to assist the operator in assessing post-accident plant status.	Improved prevention of core melt sequences by making operator actions more reliable.	Yes	B - Intent Met	Currently have SPDS in place.
150	Improve maintenance procedures.	Improved prevention of core melt sequences by increasing reliability of important equipment.	Yes	B - Intent Met	Current procedures are in line with industry guidelines and practices.
151	Increase training and operating experience feedback to improve operator response.	Improved likelihood of success of operator actions taken in response to abnormal conditions.	Yes	B - Intent Met	Current training program meets industry standards and practices.
154	Mount or anchor the MCCs to the respective building walls.	Reduces failure probability of MCCs during an earthquake	Yes	B - Intent Met	Identified in the IPEEE and successfully implemented.
155	Install shear pins (or strength bolts) in the AFW pumps.	Takes up the shear load on the pump and/or driver during an earthquake.	Yes	B - Intent Met	Identified in the IPEEE and successfully implemented.
156	Mount all fire extinguishers within their UL Standard required drop height and remove hand-held fire extinguishers from Containment during normal operation.	Reduces the potential for the fire extinguishers to fall during an earthquake and potentially fracturing upon impact with the floor or another object.	Yes	B - Intent Met	Identified in the IPEEE and successfully implemented.
157	Identify and remove unsecured equipment near areas that contain relays that actuate, so area is kept clear.	Ensures direct access to areas such as Load Shedding and Emergency Load Sequencing (LSELS) and Engineered Safety Feature Actuation System (ESFAS) cabinets. Unsecured equipment (e.g., carts, filing cabinets, and test equipment) in these areas could result	Yes	B - Intent Met	Identified in the IPEEE and successfully implemented.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
158	Properly position chain hoists that facilitate maintenance on pumps within pump rooms and institute a training program to ensure that the hoists are properly positioned when not in use.	Improper positioning of hoists reduces the availability due to moving during an earthquake and having chainfalls impacting pump oil bubblers or other soft targets resulting in failure of the pumps.	Yes	B - Intent Met	Identified in the IPEEE and successfully implemented.
159	Secure floor grating to prevent damage to sensing lines due to differential building motion.	Prevent sensing lines that pass through the grating from being damaged.	Yes	B - Intent Met	Identified in the IPEEE and successfully implemented.
166	Installation of high temperature qualified RCP seal O-rings.	Lower potential for RCP seal leakage.	Yes	B - Intent Met	High temperature O-Rings installed.
167	Addition of procedural guidance to re-establish normal service water should essential service water fail.	Provide back-up pumps for UHS cooling.	Yes	B - Intent Met	Procedures in place.
168	Addition of procedural guidance for running charging and safety injection pumps without component cooling water	Allow use of pumps following loss of component cooling water.	Yes	B - Intent Met	Procedures in place.
169	Addition of procedural guidance to verify RHR pump room cooling at switchover to ECCS recirculation phase.	Verifying that support system for RHR pumps is in service to allow continued operation of RHR pumps.	Yes	B - Intent Met	Procedures in place.
170	Modifications to add controls in the main control room to allow remote operation of nearby diesel generator farm and alignment/connection to the plant vital electrical busses.	Faster ability to provide power to the plant electrical busses from the offsite diesel generator farm.	Yes	B - Intent Met	AEPS diesel generators automatically start upon loss of offsite power to the local electrical co-op distribution system. The controls for the breakers to connect to the Callaway distribution system are in the main control room.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
172	Addition of procedural guidance and the required hardware to enable the operators to feed one or more steam generators with a diesel driven firewater pump.	Provide a backup to turbine driven auxiliary feedwater.	Yes	B - Intent Met	Procedure and hardware changes complete
173	Addition of a black start combustion turbine generator.	A redundant source of AC Power that could be used in station blackout events.	Yes	B - Intent Met	The original evaluation of this proposed modification concluded that the cost for this modification was prohibitively high. However, this was subsequently changed and the offsite Alternate Emergency Power System (AEPS) system was installed. The AEPS system consists of diesel generators and a connection to the offsite electrical Co-op.
174	Addition of a black-start engine-generator to provide AC Power during a station blackout	Ability to power a 125VDC battery charger and a charging pump. Powering the battery charger would permit operation of the TDAFP without recovering AC power. Powering a charging pump could provide RCP seal injection and preclude a RCP seal LOCA during a station blackout.	Yes	B - Intent Met	The original evaluation of this proposed modification concluded that the cost for this modification was prohibitively high. However, later implementation of the AEPS system provides the backup power source represented by this item. Also the EC Coordinator Supplemental Guidelines provide procedures and equipment for hookup of a portable generator.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
175	Replacement of the positive displacement charging pump with a third centrifugal charging pump.	Provide another source for RCP seal cooling, RCS makeup, and pumped flow for feed and bleed.	Yes	B - Intent Met	The positive displacement charging pump has been replaced by a centrifugal pump that does not require component cooling water. It is powered from a non-safety 4160 VAC power supply.
176	Provide control modifications to bypass feedwater isolation in order to restore main feedwater.	Allow faster and more reliable bypass of the main feedwater isolation signal in order to restore main feedwater to the steam generators should auxiliary feedwater fail.	Yes	B - Intent Met	Feedwater Isolation bypass switches installed and EOP in place with directions for use.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
177	Procedural and hardware modifications to reduce core damage risk due to internal flooding.	The IPE identified a need to form a task force to identify and evaluate potential procedural and hardware modifications aimed at reducing the risk due to internal flooding.	Yes	B - Intent Met	The flooding task force identified 3 generic recommendations; 1) evaluate the impact of the normal charging pump (NCP), 2) evaluate the impact of increased inspections or changes in pipe class on pipe failure probability, and 3) re-analyze pipe break flowrates for actual flow, rather than assuming pump runout flowrates. All three recommendations have been implemented. The flooding analysis credited the NCP and reduced one flood zone below the screening value. A leakage detection program was implemented which uses security personnel and operators to visually inspect specific piping in the major flood zones. The implementation of the leakage detection program reduced flooding risk sufficiently to not require the installation of some watertight doors and piping encapsulation.
140	Increase seismic ruggedness of plant components.	Increased availability of necessary plant equipment during and after seismic events.	Yes	C - Combined	Individual seismic issues identified in the IPEEE are included as SAMA items 154, 155, 156, 157, 158, and 159.

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
141	Provide additional restraints for CO_2 tanks.	Increased availability of fire protection given a seismic event.	Yes	C - Combined	Individual seismic issues identified in the IPEEE are included as SAMA items 154, 155, 156, 157, 158, and 159.
1	Provide additional DC battery capacity.	Extended DC power availability during an SBO.	No		Original battery capacity is 4 hrs. No additional battery capacity has been added. Evaluate in Phase II.
2	Replace lead-acid batteries with fuel cells.	Extended DC power availability during an SBO.	No		Plant currently uses batteries rather than fuel cells. Evaluate in Phase II.
5	Provide DC bus cross-ties.	Improved availability of DC power system.	No		No existing capability for DC bus cross-ties. Evaluate in Phase II.
11	Improve 4.16-kV bus cross-tie ability.	Increased availability of on-site AC power.	No		Evaluate during Phase II
15	Install tornado protection on gas turbine generator.	Increased availability of on-site AC power.	No		No gas turbine currently installed. No tornado protection for Alternate Emergency Power System diesel generators. Evaluate in Phase II.
24	Bury off-site power lines.	Improved off-site power reliability during severe weather.	No		Evaluate during Phase II
25	Install an independent active or passive high pressure injection system.	Improved prevention of core melt sequences.	No		Evaluate during Phase II
26	Provide an additional high pressure injection pump with independent diesel.	Reduced frequency of core melt from small LOCA and SBO sequences.	No		Evaluate during Phase II
28	Add a diverse low pressure injection system.	Improved injection capability.	No		Evaluate during Phase II

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
29	Provide capability for alternate injection via diesel-driven fire pump.	Improved injection capability.	No		Currently being evaluated by plant improvement program. Would use unborated water and portable pump (fire truck). Calculation of specific benefit of this SAMA was not performed since it is judged to be potentially low cost. Evaluation will consider impacts of injection of non-borated water.
39	Replace two of the four electric safety injection pumps with diesel-powered pumps.	Reduced common cause failure of the safety injection system. This SAMA was originally intended for the Westinghouse-CE System 80+, which has four trains of safety injection. However, the intent of this SAMA is to provide diversity within the high- and l	No		Evaluate during Phase II
41	Create a reactor coolant depressurization system.	Allows low pressure emergency core cooling system injection in the event of small LOCA and high-pressure safety injection failure.	No		Evaluate during Phase II
43	Add redundant DC control power for SW pumps.	Increased availability of SW.	No		Evaluate during Phase II
46	Add a service water pump.	Increased availability of cooling water.	No		Evaluate during Phase II
54	Increase charging pump lube oil capacity.	Increased time before charging pump failure due to lube oil overheating in loss of cooling water sequences.	No		Evaluate during Phase II
55	Install an independent reactor coolant pump seal injection system, with dedicated diesel.	Reduced frequency of core damage from loss of component cooling water, service water, or station blackout.	No		Evaluate during Phase II
56	Install an independent reactor coolant pump seal injection system, without dedicated diesel.	Reduced frequency of core damage from loss of component cooling water or service water, but not a station blackout.	No		Evaluate during Phase II

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
58	Install improved reactor coolant pump seals.	Reduced likelihood of reactor coolant pump seal LOCA.	No		Evaluate during Phase II
59	Install an additional component cooling water pump.	Reduced likelihood of loss of component cooling water leading to a reactor coolant pump seal LOCA.	No		Evaluate during Phase II
64	Implement procedure and hardware modifications to allow manual alignment of the fire water system to the component cooling water system, or install a component cooling water header cross-tie.	Improved ability to cool residual heat removal heat exchangers.	No		Evaluate during Phase II
65	Install a digital feed water upgrade.	Reduced chance of loss of main feed water following a plant trip.	No		Evaluate during Phase II
71	Install a new condensate storage tank (auxiliary feedwater storage tank).	Increased availability of the auxiliary feedwater system.	No		Evaluate during Phase II
77	Provide a passive, secondary-side heat-rejection loop consisting of a condenser and heat sink.	Reduced potential for core damage due to loss-of-feedwater events.	No		Evaluate during Phase II
79	Replace existing pilot-operated relief valves with larger ones, such that only one is required for successful feed and bleed.	Increased probability of successful feed and bleed.	No		Evaluate during Phase II
80	Provide a redundant train or means of ventilation.	Increased availability of components dependent on room cooling.	No		Evaluate during Phase II
87	Replace service and instrument air compressors with more reliable compressors which have self-contained air cooling by shaft driven fans.	Elimination of instrument air system dependence on service water cooling.	No		Air compressors currently cooled by ESW. Evaluate during Phase II
91	Install a passive containment spray system.	Improved containment spray capability.	No		Evaluate during Phase II

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
93	Install an unfiltered, hardened containment vent.	Increased decay heat removal capability for non-ATWS events, without scrubbing released fission products.	No		Evaluate during Phase II
94	Install a filtered containment vent to remove decay heat. Option 1: Gravel Bed Filter; Option 2: Multiple Venturi Scrubber	Increased decay heat removal capability for non-ATWS events, with scrubbing of released fission products.	No		Evaluate during Phase II
96	Provide post-accident containment inerting capability.	Reduced likelihood of hydrogen and carbon monoxide gas combustion.	No		Evaluate during Phase II
97	Create a large concrete crucible with heat removal potential to contain molten core debris.	Increased cooling and containment of molten core debris. Molten core debris escaping from the vessel is contained within the crucible and a water cooling mechanism cools the molten core in the crucible, preventing melt-through of the base mat.	No		Evaluate during Phase II
98	Create a core melt source reduction system.	Increased cooling and containment of molten core debris. Refractory material would be placed underneath the reactor vessel such that a molten core falling on the material would melt and combine with the material. Subsequent spreading and heat removal from the vitrified compound would be facilitated, and concrete attack would not occur.	No		Evaluate during Phase II
99	Strengthen primary/secondary containment (e.g., add ribbing to containment shell).	Reduced probability of containment over-pressurization.	No		Evaluate during Phase II
100	Increase depth of the concrete base mat or use an alternate concrete material to ensure melt-through does not occur.	Reduced probability of base mat melt-through.	No		Evaluate during Phase II

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
102	Construct a building to be connected to primary/secondary containment and maintained at a vacuum.	Reduced probability of containment over-pressurization.	No		Evaluate during Phase II
104	Improve leak detection procedures.	Increased piping surveillance to identify leaks prior to complete failure. Improved leak detection would reduce LOCA frequency.	No		Evaluate during Phase II
107	Install a redundant containment spray system.	Increased containment heat removal ability.	No		Evaluate during Phase II
108	Install an independent power supply to the hydrogen control system using either new batteries, a non-safety grade portable generator, existing station batteries, or existing AC/DC independent power supplies, such as the security system diesel.	Reduced hydrogen detonation potential.	No		Evaluate during Phase II
109	Install a passive hydrogen control system.	Reduced hydrogen detonation potential.	No		Evaluate during Phase II
110	Erect a barrier that would provide enhanced protection of the containment walls (shell) from ejected core debris following a core melt scenario at high pressure.	Reduced probability of containment failure.	No		Evaluate during Phase II
111	Install additional pressure or leak monitoring instruments for detection of ISLOCAs.	Reduced ISLOCA frequency.	No		Evaluate during Phase II
112	Add redundant and diverse limit switches to each containment isolation valve.	Reduced frequency of containment isolation failure and ISLOCAs.	No		Evaluate during Phase II
113	Increase leak testing of valves in ISLOCA paths.	Reduced ISLOCA frequency.	No		Evaluate during Phase II

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
114	Install self-actuating containment isolation valves.	Reduced frequency of isolation failure.	No		Evaluate during Phase II
115	Locate residual heat removal (RHR) inside containment	Reduced frequency of ISLOCA outside containment.	No		Evaluate during Phase II
116	Ensure ISLOCA releases are scrubbed. One method is to plug drains in potential break areas so that break point will be covered with water.	Scrubbed ISLOCA releases.	No		Evaluate during Phase II
119	Institute a maintenance practice to perform a 100% inspection of steam generator tubes during each refueling outage.	Reduced frequency of steam generator tube ruptures.	No		Current frequency of inspection of SG tubes is 100% inspection every third outage. Evaluate during Phase II
121	Increase the pressure capacity of the secondary side so that a steam generator tube rupture would not cause the relief valves to lift.	Eliminates release pathway to the environment following a steam generator tube rupture.	No		Evaluate during Phase II
122	Install a redundant spray system to depressurize the primary system during a steam generator tube rupture	Enhanced depressurization capabilities during steam generator tube rupture.	No		Evaluate during Phase II
125	Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove most of the fission products.	Reduced consequences of a steam generator tube rupture.	No		Evaluate during Phase II
126	Install a highly reliable (closed loop) steam generator shell-side heat removal system that relies on natural circulation and stored water sources	Reduced consequences of a steam generator tube rupture.	No		Evaluate during Phase II

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
129	Vent main steam safety valves in containment.	Reduced consequences of a steam generator tube rupture.	No		Evaluate during Phase II
130	Add an independent boron injection system.	Improved availability of boron injection during ATWS.	No		Evaluate during Phase II
131	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS.	Improved equipment availability after an ATWS.	No		Evaluate during Phase II
133	Install an ATWS sized filtered containment vent to remove decay heat.	Increased ability to remove reactor heat from ATWS events.	No		Evaluate during Phase II
136	Install motor generator set trip breakers in control room.	Reduced frequency of core damage due to an ATWS.	No		Evaluate during Phase II
147	Install digital large break LOCA protection system.	Reduced probability of a large break LOCA (a leak before break).	No		Evaluate during Phase II
153	Install secondary side guard pipes up to the main steam isolation valves.	Prevents secondary side depressurization should a steam line break occur upstream of the main steam isolation valves. Also guards against or prevents consequential multiple steam generator tube ruptures following a main steam line break event.	No		Evaluate during Phase II
160	Modifications to lessen impact of internal flooding path through Control Building dumbwaiter.	Lower impact of flood that propagates through the dumbwaiter	No		Evaluate during Phase II
161	Improvements to PORV performance that will lower the probability of failure to open.	Decrease in risk due to PORV failing to open.	No		Evaluate during Phase II
162	Install a large volume EDG fuel oil tank at an elevation greater than the EDG fuel oil day tanks.	Allows transfer of EDF fuel oil to the EDG day tanks on failure of the fuel oil transfer pumps.	No		Evaluate during Phase II

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
163	Improve feedwater check valve reliability to reduce probability of failure to open.	Lower risk due to failures in which feedwater check valves fail to open and allow feeding of the steam generators.	No		Valves replaced with new type, but are still significant risk contributor. Evaluate in Phase II.
164	Provide the capability to power the normal service water pumps from AEPS.	Provide backup to ESW in conditions with power only available from AEPS.	No		Evaluate during Phase II
171	Increase the size of the RWST or otherwise improve the availability of the RWST	Ensure a supply of makeup water is available from the RWST.	No		Evaluate during Phase II
178	Improvements to UHS cooling tower electrical room HVAC.	Improve availability or mitigate loss of HVAC.	No		Evaluate during Phase II
179	Modify procedures such that the water loop seals in the RCS cold legs are not cleared following core damage.	Prevents possible thermally induced steam generator tube rupture following core damage.	No		Evaluate during Phase II
180	Install lower amperage fuses for various 14 AWG control circuits in the MCR. The majority of the modification centers around the trip circuit fuses on NB, NG, PA, PB, and PG system breakers.	Reduced fire risk.	No		Evaluate during Phase II
181	Install redundant fuses and isolation switches for MCR evacuation procedure OTO-ZZ-00001.	Reduced fire risk.	No		Evaluate during Phase II

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
182	To protect against multiple spurious operation scenarios, cable runs will be changed to run a single wire in a protected metal jacket such that spurious valve opening due to a hot short affecting the valve control circuit is eliminated for the fire area. This modification will be implemented in multiple fire areas.	Reduced fire risk.	No		Evaluate during Phase II
183	Quick response sprinkler heads in cable chases A-11, C-30, and C-31 will be modified to be in accordance with the applicable requirements of NFPA 13-1976 edition.	Reduced fire risk.	No		Evaluate during Phase II
184	Improvements in the reliability of the Steam Line Isolation automatic signal.	More reliable main steam line isolation.	No		Evaluate during Phase II
185	Automate initiation of CCW flow to the RHR heat exchangers.	More reliable than manual initiation of flow to RRHR HX.	No		Evaluate during Phase II
186	Develop a procedure and obtain equipment to provide a temporary hookup of fire water as a replacement for ESW	Backup cooling water if ESW/SW is lost	No		Evaluate during Phase II
187	Install modification to power the normal charging pump from an existing spare breaker from the AEPS.	Another source of backup power to the NCP in cases of station blackout or loss of service water	No		Evaluate during Phase II
188	Install a permanent, dedicated generator for the NCP, and a motor-driven AFW pump and battery charger to address SBO events in which the TD AFW pump is unavailable.	Another source of backup power to the NCP, DC power (pump/valve control and SG level instrumentation), and power to an AFW pump in cases of station blackout or loss of service water	No		Evaluate during Phase II

Table 6-1. Callaway Plant Phase I SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	Screened Out Ph 1?	Screening Criterion	Phase I Disposition
189	Perform analysis to determine if it is possible to modify current plant doors to withstand higher flood heights. Either perform modifications to install improved doors or revise flooding analysis to incorporate results that doors will withstand higher flooding heights without propagating the flood.	Reduction in risk due to internal flooding.	No		Evaluate during Phase II

Table 7-1. Callaway Plant 1 Phase II SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	% Red IN OECR	Cost Basis	Evaluation	Basis for Evaluation
1	Provide additional DC battery capacity.	Extended DC power availability during an SBO.	12.17%	10.87%	NOSBO	No Station Blackout Events	$360K	>$1M	10.49%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
2	Replace lead-acid batteries with fuel cells.	Extended DC power availability during an SBO.	12.17%	10.87%	NOSBO	No Station Blackout Events	$360K	>$1M	10.49%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
5	Provide DC bus cross-ties.	Improved availability of DC power system.	0.30%	0.00%	DC01	TDAFW no DC Dependency	$1K	>$199K	0.03%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
11	Improve 4.16-kV bus cross-tie ability.	Increased availability of on-site AC power.	0.26%	0.58%	4kv2	Add 4KV cross-tie capability for SBO sequences	$13K	<$100K	0.58%	Expert Panel	Potentially Cost-Beneficial	Physical cross-tie exists, but there is no analysis or procedures to allow its use except in specific outage conditions. Cost is to develop procedures and analysis to allow use of the cross-tie. Benefit calculated is under-estimated since it was evaluated for only SBO sequences.
15	Install tornado protection on gas turbine generator.	Increased availability of on-site AC power.	2.65%	4.35%	LOSP1	No tornado related LOSP	$91K	>$500K	3.38%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
24	Bury off-site power lines.	Improved off-site power reliability during severe weather.	40.66%	41.30%	NOLOSP	Eliminate all Loss of Offsite Power Events	$1.2M	>$3M	35.28%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit. Previous SAMA submittals have estimated approximately $1M per mile.
25	Install an independent active or passive high pressure injection system.	Improved prevention of core melt sequences.	16.46%	0.00%	LOCA12	No failures of the charging or SI pumps	$616K	>$1.5M	22.61%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
26	Provide an additional high pressure injection pump with independent diesel.	Reduced frequency of core melt from small LOCA and SBO sequences.	16.46%	0.00%	LOCA12	No failures of the charging or SI pumps	$616K	>$1.5M	22.61%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
28	Add a diverse low pressure injection system.	Improved injection capability.	3.19%	2.17%	LOCA03	No failure of low pressure injection	$65K	>$1M	1.01%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.

Table 7-1. Callaway Plant 1 Phase II SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	% Red IN OECR	Cost Basis	Evaluation	Basis for Evaluation
29	Provide capability for alternate injection via diesel-driven fire pump.	Improved injection capability.									Potentially Cost-Beneficial	SAMA is judged to be low cost, but analysis is needed to determine impacts of injection of non-borated water to RCS. Expert Panel judged this SAMA to be potentially cost-beneficial without determining an actual benefit or cost.
39	Replace two of the four electric safety injection pumps with diesel-powered pumps.	Reduced common cause failure of the safety injection system. This SAMA was originally intended for the Westinghouse-CE System 80+, which has four trains of safety injection. However, the intent of this SAMA is to provide diversity within the high- and l	16.46%	0.00%	LOCA12	No failures of the charging or SI pumps	$616K	>$1.5M	22.61%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
41	Create a reactor coolant depressurization system.	Allows low pressure emergency core cooling system injection in the event of small LOCA and high-pressure safety injection failure.	0.78%	0.00%	DEPRESS	No failures of depressurization	$12K	>$500K	0.27%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
43	Add redundant DC control power for SW pumps.	Increased availability of SW.	0.30%	0.00%	SW01	Service Water Pumps not dependent on DC Power	$1K	>$100K	0.06%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
46	Add a service water pump.	Increased availability of cooling water.	17.60%	27.72%	SW02	No failures of ESW pumps	$636K	>$5M	23.26%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
54	Increase charging pump lube oil capacity.	Increased time before charging pump failure due to lube oil overheating in loss of cooling water sequences.	0.48%	0.00%	CHG01	Charging pumps not dependent on cooling water.	$4K	>$100K	0.06%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.

Table 7-1. Callaway Plant 1 Phase II SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	% Red IN OECR	Cost Basis	Evaluation	Basis for Evaluation
55	Install an independent reactor coolant pump seal injection system, with dedicated diesel.	Reduced frequency of core damage from loss of component cooling water, service water, or station blackout.	5.54%	0.00%	RCPLOCA	No RCP Seal LOCAs	$94K	>$1M	0.21%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit. Previous investigation into installing such a system concluded that operators did not have sufficient time to place the system in service prior to seal damage.
56	Install an independent reactor coolant pump seal injection system, without dedicated diesel.	Reduced frequency of core damage from loss of component cooling water or service water, but not a station blackout.	5.54%	0.00%	RCPLOCA	No RCP Seal LOCAs	$94K	>$500K	0.21%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
58	Install improved reactor coolant pump seals.	Reduced likelihood of reactor coolant pump seal LOCA.	5.54%	0.00%	RCPLOCA	No RCP Seal LOCAs	$94K	>$3M	0.21%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
59	Install an additional component cooling water pump.	Reduced likelihood of loss of component cooling water leading to a reactor coolant pump seal LOCA.	3.61%	0.00%	CCW01	No failures of the CCW Pumps	$59K	>$1M	0.07%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
64	Implement procedure and hardware modifications to allow manual alignment of the fire water system to the component cooling water system, or install a component cooling water header cross-tie.	Improved ability to cool residual heat removal heat exchangers.	5.39%	0.76%	FWCCW2	Evaluate fire water hookup to RHR HX	$104K	<$150K	0.77%%	Expert Panel	Potentially Cost Beneficial	The cost estimate is for development of a procedure and use of temporary connections. Cost of permanent modification would be significantly higher.
65	Install a digital feed water upgrade.	Reduced chance of loss of main feed water following a plant trip.	1.57%	0.00%	FW01	No loss of Feedwater Events	$29K	$19M	0.49%	Callaway Modification Costs	Not Cost-Beneficial	Cost will exceed benefit.
71	Install a new condensate storage tank (auxiliary feedwater storage tank).	Increased availability of the auxiliary feedwater system.	1.14%	0.00%	CST01	CST does not deplete	$18K	>$2.5M	0.24%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
77	Provide a passive, secondary-side heat-rejection loop consisting of a condenser and heat sink.	Reduced potential for core damage due to loss-of-feedwater events.	1.57%	0.00%	FW01	No loss of Feedwater Events	$29K	$>1M	0.49%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.

Table 7-1. Callaway Plant 1 Phase II SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	% Red IN OECR	Cost Basis	Evaluation	Basis for Evaluation
79	Replace existing pilot-operated relief valves with larger ones, such that only one is required for successful feed and bleed.	Increased probability of successful feed and bleed.	3.43%	2.17%	FB01	Only one PORV required for Feed & Bleed	$79K	>$500K	1.68%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
80	Provide a redundant train or means of ventilation.	Increased availability of components dependent on room cooling.	6.08%	4.35%	HVAC	No dependencies on HVAC	$156K	<$100K	3.87%	Expert Panel	Potentially Cost Beneficial	Procedures to open doors or provide temporary ventilation may be cost beneficial for the EDGs, MDAFW pumps, and charging pumps. Procedures for opening doors to the DC switchgear rooms exist.
87	Replace service and instrument air compressors with more reliable compressors which have self-contained air cooling by shaft driven fans.	Elimination of instrument air system dependence on service water cooling.	0.36%	0.00%	INSTAIR	Eliminate all instrument air failures	$2K	>$500K	0.06%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
91	Install a passive containment spray system.	Improved containment spray capability.	19.52%	36.96%	CONT01	No failures due to containment overpressure	$793K	>$10M	31.32%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
93	Install an unfiltered, hardened containment vent.	Increased decay heat removal capability for non-ATWS events, without scrubbing released fission products.	19.52%	36.96%	CONT01	No failures due to containment overpressure	$793K	>$2M	31.32%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
94	Install a filtered containment vent to remove decay heat. Option 1: Gravel Bed Filter; Option 2: Multiple Venturi Scrubber	Increased decay heat removal capability for non-ATWS events, with scrubbing of released fission products.	19.52%	36.96%	CONT01	No failures due to containment overpressure	$793K	>$2M	31.32%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
96	Provide post-accident containment inerting capability.	Reduced likelihood of hydrogen and carbon monoxide gas combustion.	0.48%	0.00%	H2BURN	No hydrogen burns/explosions	$10K	>$100K	0.44%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.

Table 7-1. Callaway Plant 1 Phase II SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	% Red IN OECR	Cost Basis	Evaluation	Basis for Evaluation
97	Create a large concrete crucible with heat removal potential to contain molten core debris.	Increased cooling and containment of molten core debris. Molten core debris escaping from the vessel is contained within the crucible and a water cooling mechanism cools the molten core in the crucible, preventing melt-through of the base mat.			MAB			>$10M	Note 1	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
98	Create a core melt source reduction system.	Increased cooling and containment of molten core debris. Refractory material would be placed underneath the reactor vessel such that a molten core falling on the material would melt and combine with the material. Subsequent spreading and heat removal from the vitrified compound would be facilitated, and concrete attack would not occur.			MAB			>$10M	Note 1	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
99	Strengthen primary/secondary containment (e.g., add ribbing to containment shell).	Reduced probability of containment over-pressurization.	19.52%	36.96%	CONT01	No failures due to containment overpressure	$1.2M	>$10M	31.32%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
100	Increase depth of the concrete base mat or use an alternate concrete material to ensure melt-through does not occur.	Reduced probability of base mat melt-through.			MAB			>$10M	Note 1	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
102	Construct a building to be connected to primary/secondary containment and maintained at a vacuum.	Reduced probability of containment over-pressurization.	19.52%	36.96%	CONT01	No failures due to containment overpressure	$1.2M	>$10M	31.32%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
104	Improve leak detection procedures.	Increased piping surveillance to identify leaks prior to complete failure. Improved leak detection would reduce LOCA frequency.	39.34%	2.17%	LOCA05	No piping system LOCAs	$689K	>$2M	1.03%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.

Table 7-1. Callaway Plant 1 Phase II SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	% Red IN OECR	Cost Basis	Evaluation	Basis for Evaluation
107	Install a redundant containment spray system.	Increased containment heat removal ability.	19.52%	36.96%	CONT01	No failures due to containment overpressure	$1.2M	>$2M	31.32%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
108	Install an independent power supply to the hydrogen control system using either new batteries, a non-safety grade portable generator, existing station batteries, or existing AC/DC independent power supplies, such as the security system diesel.	Reduced hydrogen detonation potential.	0.48%	0.00%	H2BURN	No hydrogen burns/explosions	$10K	>$100K	0.44%	Expert Panel	Not Cost-Beneficial	
109	Install a passive hydrogen control system.	Reduced hydrogen detonation potential.	0.48%	0.00%	H2BURN	No hydrogen burns/explosions	$10K	>$100M	0.44%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
110	Erect a barrier that would provide enhanced protection of the containment walls (shell) from ejected core debris following a core melt scenario at high pressure.	Reduced probability of containment failure.			MAB			>$10M	Note 1	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
111	Install additional pressure or leak monitoring instruments for detection of ISLOCAs.	Reduced ISLOCA frequency.	1.33%	8.70%	ISLOCA	No ISLOCA events	$123K	>$500K	7.08%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
112	Add redundant and diverse limit switches to each containment isolation valve.	Reduced frequency of containment isolation failure and ISLOCAs.	0.30%	0.00%	CONT02	No failures of containment isolation	$1K	>$1M		Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
113	Increase leak testing of valves in ISLOCA paths.	Reduced ISLOCA frequency.	1.33%	8.70%	ISLOCA	No ISLOCA events	$123K	>$1M	7.08%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
114	Install self-actuating containment isolation valves.	Reduced frequency of isolation failure.	0.30%	0.00%	CONT02	No failures of containment isolation	$1K	>$500K	0.03%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
115	Locate residual heat removal (RHR) inside containment	Reduced frequency of ISLOCA outside containment.	1.33%	8.70%	ISLOCA	No ISLOCA events	$123K	>$1M	7.08%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
116	Ensure ISLOCA releases are scrubbed. One method is to plug drains in potential break areas so that break point will be covered with water.	Scrubbed ISLOCA releases.	1.33%	8.70%	ISLOCA	No ISLOCA events	$123K	>$1M	7.08%	Expert Panel	Not Cost-Beneficial	Cost would exceed benefit. Current plant design requires drains to be open. Analysis and license changes required to implement are included in the cost estimate.

Table 7-1. Callaway Plant 1 Phase II SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	% Red IN OECR	Cost Basis	Evaluation	Basis for Evaluation
119	Institute a maintenance practice to perform a 100% inspection of steam generator tubes during each refueling outage.	Reduced frequency of steam generator tube ruptures.	20.47%	63.28%	NOSGTR	No SGTR Events	$1.4M	>$3M	69.43%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
121	Increase the pressure capacity of the secondary side so that a steam generator tube rupture would not cause the relief valves to lift.	Eliminates release pathway to the environment following a steam generator tube rupture.	20.47%	63.28%	NOSGTR	No SGTR Events	$1.4M	>$10M	69.43%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
122	Install a redundant spray system to depressurize the primary system during a steam generator tube rupture	Enhanced depressurization capabilities during steam generator tube rupture.	20.47%	63.28%	NOSGTR	No SGTR Events	$1.4M	>$10M	69.43%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
125	Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove most of the fission products.	Reduced consequences of a steam generator tube rupture.	20.47%	63.28%	NOSGTR	No SGTR Events	$1.4M	>$10M	69.43%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
126	Install a highly reliable (closed loop) steam generator shell-side heat removal system that relies on natural circulation and stored water sources	Reduced consequences of a steam generator tube rupture.	20.47%	63.28%	NOSGTR	No SGTR Events	$1.4M	>$10M	69.43%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
129	Vent main steam safety valves in containment.	Reduced consequences of a steam generator tube rupture.	20.47%	63.28%	NOSGTR	No SGTR Events	$1.4M	>$10M	69.43%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit. Current containment design does not support this modification. Modifications to containment and associated analysis are included in the cost estimate.
130	Add an independent boron injection system.	Improved availability of boron injection during ATWS.	2.41%	2.17%	NOATWS	Eliminate all ATWS	$63K	>$1M	1.85%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
131	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS.	Improved equipment availability after an ATWS.	2.41%	2.17%	NOATWS	Eliminate all ATWS	$63K	>$2M	1.85%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.

Table 7-1. Callaway Plant 1 Phase II SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	% Red IN OECR	Cost Basis	Evaluation	Basis for Evaluation
133	Install an ATWS sized filtered containment vent to remove decay heat.	Increased ability to remove reactor heat from ATWS events.	2.41%	2.17%	NOATWS	Eliminate all ATWS	$63K	>$1M	1.85%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit
136	Install motor generator set trip breakers in control room.	Reduced frequency of core damage due to an ATWS.	2.41%	2.17%	NOATWS	Eliminate all ATWS	$63K	>$500K	1.85%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
147	Install digital large break LOCA protection system.	Reduced probability of a large break LOCA (a leak before break).	39.34%	2.17%	LOCA05	No piping system LOCAs	$689K	>$5M	1.03%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
153	Install secondary side guard pipes up to the main steam isolation valves.	Prevents secondary side depressurization should a steam line break occur upstream of the main steam isolation valves. Also guards against or prevents consequential multiple steam generator tube ruptures following a main steam line break event.	2.53%	0.00%	NOSLB	No Steam Line Breaks	$51K	>$1M	0.87%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
160	Modifications to lessen impact of internal flooding path through Control Building dumbwaiter.	Lower impact of flood that propagates through the dumbwaiter						<$50K		Expert Panel	Potentially Cost-Beneficial	Relatively minor modifications to door opening could result in lower flow to the dumbwaiter. Specific benefit could not be calculated but SAMA item is judged to be low cost and therefore potentially cost beneficial.
161	Improvements to PORV performance that will lower the probability of failure to open.	Decrease in risk due to PORV failing to open.	0.85%	0.46%	PORV	PORVs do not fail to open	$18K	>$100K	0.24%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
162	Install a large volume EDG fuel oil tank at an elevation greater than the EDG fuel oil day tanks.	Allows transfer of EDF fuel oil to the EDG day tanks on failure of the fuel oil transfer pumps.	1.14%	7.60%	EDGFUEL	No EDG fuel pump failures	$124K	$150K	7.11%	Wolf Creek	Potentially Cost-Beneficial	Wolf Creek estimated cost of $150K is less than the potential benefit.
163	Improve feedwater check valve reliability to reduce probability of failure to open.	Lower risk due to failures in which feedwater check valves fail to open and allow feeding of the steam generators.	5.52%	2.05%	FW02	Feedwater Check Valves do not fail to open	$127K	>$500K	2.23%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.

Table 7-1. Callaway Plant 1 Phase II SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	% Red IN OECR	Cost Basis	Evaluation	Basis for Evaluation
164	Provide the capability to power the normal service water pumps from AEPS.	Provide backup to ESW in conditions with power only available from AEPS.	5.62%	7.64%	SW03	AEPS power to SW pumps	$191K	>$500K	6.37%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
171	Increase the size of the RWST or otherwise improve the availability of the RWST	Ensure a supply of makeup water is available from the RWST.	0.68%	0.13%	LOCA04	RWST does not deplete	$13K	>$100K	0.07%	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
178	Improvements to UHS cooling tower electrical room HVAC.	Improve availability or mitigate loss of HVAC.	3.29%	4.75% %	HVAC02	UHS cooling tower electrical room HVAC does not fail.	$113K	<$100K	3.82%	Expert Panel	Potentially Cost Beneficial	Implementation of temporary ventilation or opening of doors will be a lower cost than the calculated benefit.
179	Modify procedures such that the water loop seals in the RCS cold legs are not cleared following core damage.	Prevents possible thermally induced steam generator tube rupture following core damage.	0.15%	3.18%	RAI7a	Reduced probability of thermally induced steam generator tube failure	$63K	<$100K	4.46%	Expert Panel	Potentially Cost Beneficial	Implementation of procedure change will be lower cost than benefit, especially if 95% CDF benefit is considered.
180	Install lower amperage fuses for various 14 AWG control circuits in the MCR. The majority of the modification centers around the trip circuit fuses on NB, NG, PA, PB, and PG system breakers.	Reduced fire risk.									Potentially Cost Beneficial	SAMA considered potentially cost beneficial without benefit or cost determination since the NFPA 805 license amendment request committed to performing the modification.
181	Install redundant fuses and isolation switches for MCR evacuation procedure OTO-ZZ-00001.	Reduced fire risk.									Potentially Cost Beneficial	SAMA considered potentially cost beneficial without benefit or cost determination since the NFPA 805 license amendment request committed to performing the modification.

Table 7-1. Callaway Plant 1 Phase II SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	% Red IN OECR	Cost Basis	Evaluation	Basis for Evaluation
182	To protect against multiple spurious operation scenarios, cable runs will be changed to run a single wire in a protected metal jacket such that spurious valve opening due to a hot short affecting the valve control circuit is eliminated for the fire area. This modification will be implemented in multiple fire areas.	Reduced fire risk.									Potentially Cost Beneficial	SAMA considered potentially cost beneficial without benefit or cost determination since the NFPA 805 license amendment request committed to performing the modification.
183	Quick response sprinkler heads in cable chases A-11, C-30, and C-31 will be modified to be in accordance with the applicable requirements of NFPA 13-1976 edition.	Reduced fire risk.									Potentially Cost Beneficial	SAMA considered potentially cost beneficial without benefit or cost determination since the NFPA 805 license amendment request committed to performing the modification.
184	Improvements in the reliability of the Steam Line Isolation automatic signal.	More reliable main steam line isolation.	0.59%	0.95%	SLIS	Steam Line Isolation System does not fail	$28K	>$500K	1.06%	Expert Panel	Not Cost-Beneficial	Cost is for installation of redundant instrumentation system and would likely be much higher. Procedure and training already direct operators to manually back up failed automatic actuations.
185	Automate initiation of CCW flow to the RHR heat exchangers.	More reliable than manual initiation of flow to RHR HX.	3.53%	0.14%	HEP	Evaluate automating CCW flow to RHR HXs	$62K	$200K	0.11%	Expert Panel	Potentially Cost Beneficial	
186	Develop a procedure and obtain equipment to provide a temporary hookup of fire water as a replacement for ESW	Backup cooling water if ESW/SW is lost	0.04%	0.05%	FWCCW	Fire water available to cool CCW HX	$1K	>$1M	0.04%	Expert Panel	Not Cost-Beneficial	Ability to do this will require larger fire pumps.
187	Install modification to power the normal charging pump from an existing spare breaker from the AEPS.	Another source of backup power to the NCP in cases of station blackout or loss of service water	4.07%	7.63%	SBOMOD	Reduce the frequency of SBO sequences.	$174K	$350K	7.03%	Expert Panel	Potentially Cost Beneficial	Already installed spare circuit breaker, implementation requires power and control cables.

Table 7-1. Callaway Plant 1 Phase II SAMA Analysis

Callaway SAMA Number	Potential Improvement	Discussion	% Red. In CDF	% Red. In OS Dose	SAMA Case	SAMA Case Description	Benefit	Cost	% Red IN OECR	Cost Basis	Evaluation	Basis for Evaluation
188	Install a permanent, dedicated generator for the NCP, and a motor-driven AFW pump and battery charger to address SBO events in which the TD AFW pump is unavailable.	Another source of backup power to the NCP, DC power (pump/valve control and SG level instrumentation), and power to an AFW pump in cases of station blackout or loss of service water	4.28%	7.63%	SBOMOD2	Reduce the frequency of SBO sequences.	$182K	$400K	7.38%	Expert Panel	Potentially Cost Beneficial	AEPS was installed with a spare breaker and expansion capability that could be used to supply various equipment.
189	Perform analysis to determine if it is possible to modify current plant doors to withstand higher flood heights. Either perform modifications to install improved doors or revise flooding analysis to incorporate results that doors will withstand higher flooding heights without propagating the flood.	Reduction in risk due to internal flooding.								Callaway Plant Management	Potentially Cost Beneficial	Installation of modified doors or modification of flooding analysis will result in lower flooding risk. Analysis is currently in progress.

OS = off site

Note 1: For SAMA items that were judged to cost significantly more than the Maximum Attainable Benefit (MAB), no calculation of the individual benefit was performed.

Table 8-1. Callaway Plant Sensitivity Evaluation

Callaway SAMA Number	Potential Improvement	Discussion	SAMA Case	Benefit	Benefit at 3% Disc Rate	Benefit at Realistic Disc Rate	Benefit at 33yrs	Benefit at 95% CDF	Cost	Cost Basis	Evaluation	Basis for Evaluation
1	Provide additional DC battery capacity.	Extended DC power availability during an SBO.	NOSBO	$360K	$588K	$325K	$512K	$761K	>$1M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
2	Replace lead-acid batteries with fuel cells.	Extended DC power availability during an SBO.	NOSBO	$360K	$588K	$325K	$512K	$761K	>$1M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
5	Provide DC bus cross-ties.	Improved availability of DC power system.	DC01	$1K	$1K	$1K	$1K	$1K	>$199K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
11	Improve 4.16-kV bus cross-tie ability.	Increased availability of on-site AC power.	4kv2	$13K	$20K	$12K	$17K	$27K	<$100K	Expert Panel	Potentially Cost-Beneficial	Physical cross-tie exists, but there is no analysis or procedures to allow its use except in specific outage conditions. Cost is to develop procedures and analysis to allow use of the cross-tie. Benefit calculated is under-estimated since it was evaluated for only SBO sequences.
15	Install tornado protection on gas turbine generator.	Increased availability of on-site AC power.	LOSP1	$91K	$144K	$82K	$125K	$192K	>$500K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
24	Bury off-site power lines.	Improved off-site power reliability during severe weather.	NOLOSP	$1.2M	$2.0M	$1.1M	$1.7M	$2.6M	>$3M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit. Previous SAMA submittals have estimated approximately $1M per mile.
25	Install an independent active or passive high pressure injection system.	Improved prevention of core melt sequences.	LOCA12	$616K	$979K	$557K	$850	$1.3M	>$1.5M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
26	Provide an additional high pressure injection pump with independent diesel.	Reduced frequency of core melt from small LOCA and SBO sequences.	LOCA12	$616K	$979K	$557K	$850	$1.3M	>$1.5M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
28	Add a diverse low pressure injection system.	Improved injection capability.	LOCA03	$65K	$111K	$58K	$97K	$137K	>$1M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.

Table 8-1. Callaway Plant Sensitivity Evaluation

Callaway SAMA Number	Potential Improvement	Discussion	SAMA Case	Benefit	Benefit at 3% Disc Rate	Benefit at Realistic Disc Rate	Benefit at 33yrs	Benefit at 95% CDF	Cost	Cost Basis	Evaluation	Basis for Evaluation
29	Provide capability for alternate injection via diesel-driven fire pump.	Improved injection capability.									Potentially Cost-Beneficial	SAMA is judged to be low cost, but analysis is needed to determine impacts of injection of non-borated water to RCS. Expert Panel judged this SAMA to be potentially cost-beneficial without determining an actual benefit or cost.
39	Replace two of the four electric safety injection pumps with diesel-powered pumps.	Reduced common cause failure of the safety injection system. This SAMA was originally intended for the Westinghouse-CE System 80+, which has four trains of safety injection. However, the intent of this SAMA is to provide diversity within the high- and l	LOCA12	$616K	$979K	$557K	$850K	$1.3M	>$1.5M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
41	Create a reactor coolant depressurization system.	Allows low pressure emergency core cooling system injection in the event of small LOCA and high-pressure safety injection failure.	DEPRESS	$12K	$20K	$11K	$17K	$25K	>$500K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
43	Add redundant DC control power for SW pumps.	Increased availability of SW.	SW01	$1K	$2K	$1K	$2K	$3K	>$100K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
46	Add a service water pump.	Increased availability of cooling water.	SW02	$636K	$1M	$575K	$879K	$1.3M	>$5M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
54	Increase charging pump lube oil capacity.	Increased time before charging pump failure due to lube oil overheating in loss of cooling water sequences.	CHG01	$4K	$7K	$4K	$6K	$9K	>$100K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
55	Install an independent reactor coolant pump seal injection system, with dedicated diesel.	Reduced frequency of core damage from loss of component cooling water, service water, or station blackout.	RCPLOCA	$94K	$168K	$85K	$148K	$198K	>$1M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit. Previous investigation into installing such a system concluded that operators did not have sufficient time to place the system in service prior to seal damage.

Table 8-1. Callaway Plant Sensitivity Evaluation

Callaway SAMA Number	Potential Improvement	Discussion	SAMA Case	Benefit	Benefit at 3% Disc Rate	Benefit at Realistic Disc Rate	Benefit at 33yrs	Benefit at 95% CDF	Cost	Cost Basis	Evaluation	Basis for Evaluation
56	Install an independent reactor coolant pump seal injection system, without dedicated diesel.	Reduced frequency of core damage from loss of component cooling water or service water, but not a station blackout.	RCPLOCA	$94K	$168K	$85K	$148K	$198K	>$500K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
58	Install improved reactor coolant pump seals.	Reduced likelihood of reactor coolant pump seal LOCA.	RCPLOCA	$94K	$168K	$85K	$148K	$198K	>$3M		Not Cost-Beneficial	Cost will exceed benefit.
59	Install an additional component cooling water pump.	Reduced likelihood of loss of component cooling water leading to a reactor coolant pump seal LOCA.	CCW01	$59K	$106K	$53K	$93K	$124K	>$1M	Cost will exceed benefit	Not Cost-Beneficial	Cost will exceed benefit.
64	Implement procedure and hardware modifications to allow manual alignment of the fire water system to the component cooling water system, or install a component cooling water header cross-tie.	Improved ability to cool residual heat removal heat exchangers.	FWCCW2	$104K	$184K	$94K	$161K	$220K	<$150K	Expert Panel	Potentially Cost Beneficial	The cost estimate is for development of a procedure and use of temporary connections. Cost of permanent modification would be significantly higher.
65	Install a digital feed water upgrade.	Reduced chance of loss of main feed water following a plant trip.	FW01	$29K	$50K	$27K	$44K	$62K	$19M	Callaway Modification Costs	Not Cost-Beneficial	Cost will exceed benefit.
71	Install a new condensate storage tank (auxiliary feedwater storage tank).	Increased availability of the auxiliary feedwater system.	CST01	$18K	$32K	$16K	$28K	$39K	>$2.5M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
77	Provide a passive, secondary-side heat-rejection loop consisting of a condenser and heat sink.	Reduced potential for core damage due to loss-of-feedwater events.	FW01	$29K	$50K	$27K	$44K	$62K	$>1M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
79	Replace existing pilot-operated relief valves with larger ones, such that only one is required for successful feed and bleed.	Increased probability of successful feed and bleed.	FB01	$79K	$133K	$72K	$117K	$168K	>$500K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
80	Provide a redundant train or means of ventilation.	Increased availability of components dependent on room cooling.	HVAC	$156K	$259K	$141K	$227K	$331K	<$100K	Expert Panel	Potentially Cost Beneficial	Procedures to open doors or provide temporary ventilation may be cost beneficial for the EDGs, MDAFW pumps, and charging pumps. Procedures for opening doors to the DC switchgear rooms exist.

Table 8-1. Callaway Plant Sensitivity Evaluation

Callaway SAMA Number	Potential Improvement	Discussion	SAMA Case	Benefit	Benefit at 3% Disc Rate	Benefit at Realistic Disc Rate	Benefit at 33yrs	Benefit at 95% CDF	Cost	Cost Basis	Evaluation	Basis for Evaluation
87	Replace service and instrument air compressors with more reliable compressors which have self-contained air cooling by shaft driven fans.	Elimination of instrument air system dependence on service water cooling.	INSTAIR	$2K	$3K	$2K	$$2K	$4K	>$500K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
91	Install a passive containment spray system.	Improved containment spray capability.	CONT01	$793K	$1.2M	$717K	$1.1M	$1.7M	>$10M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
93	Install an unfiltered, hardened containment vent.	Increased decay heat removal capability for non-ATWS events, without scrubbing released fission products.	CONT01	$793K	$1.2M	$717K	$1.1M	$1.7M	>$2M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
94	Install a filtered containment vent to remove decay heat. Option 1: Gravel Bed Filter; Option 2: Multiple Venturi Scrubber	Increased decay heat removal capability for non-ATWS events, with scrubbing of released fission products.	CONT01	$793K	$1.2M	$717K	$1.1M	$1.7M	>$2M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
96	Provide post-accident containment inerting capability.	Reduced likelihood of hydrogen and carbon monoxide gas combustion.	H2BURN	$10K	$15K	$9K	$13K	$20K	>$100K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
97	Create a large concrete crucible with heat removal potential to contain molten core debris.	Increased cooling and containment of molten core debris. Molten core debris escaping from the vessel is contained within the crucible and a water cooling mechanism cools the molten core in the crucible, preventing melt-through of the base mat.	MAB						>$10M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
98	Create a core melt source reduction system.	Increased cooling and containment of molten core debris. Refractory material would be placed underneath the reactor vessel such that a molten core falling on the material would melt and combine with the material. Subsequent spreading and heat removal from the vitrified compound would be facilitated, and concrete attack would not occur.	MAB						>$10M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
99	Strengthen primary/secondary containment (e.g., add ribbing to containment shell).	Reduced probability of containment over-pressurization.	CONT01	$1.2M	$1.2M	$717K	$1.1M	$1.7M	>$10M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.

Table 8-1. Callaway Plant Sensitivity Evaluation

Callaway SAMA Number	Potential Improvement	Discussion	SAMA Case	Benefit	Benefit at 3% Disc Rate	Benefit at Realistic Disc Rate	Benefit at 33yrs	Benefit at 95% CDF	Cost	Cost Basis	Evaluation	Basis for Evaluation
100	Increase depth of the concrete base mat or use an alternate concrete material to ensure melt-through does not occur.	Reduced probability of base mat melt-through.	MAB						>$10M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
102	Construct a building to be connected to primary/secondary containment and maintained at a vacuum.	Reduced probability of containment over-pressurization.	CONT01	$1.2M	$1.2M	$717K	$1.1M	$1.7M	>$10M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
104	Improve leak detection procedures.	Increased piping surveillance to identify leaks prior to complete failure. Improved leak detection would reduce LOCA frequency.	LOCA05	$685K	$1.2M	$620K	$1.1M	$1.5M	>$2M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
107	Install a redundant containment spray system.	Increased containment heat removal ability.	CONT01	$1.2M	$1.2M	$717K	$1.1M	$1.7M	>$2M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
108	Install an independent power supply to the hydrogen control system using either new batteries, a non-safety grade portable generator, existing station batteries, or existing AC/DC independent power supplies, such as the security system diesel.	Reduced hydrogen detonation potential.	H2BURN	$10K	$15K	$9K	$13K	$20K	>$100K	Expert Panel	Not Cost-Beneficial	
109	Install a passive hydrogen control system.	Reduced hydrogen detonation potential.	H2BURN	$10K	$15K	$9K	$13K	$20K	>$100M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
110	Erect a barrier that would provide enhanced protection of the containment walls (shell) from ejected core debris following a core melt scenario at high pressure.	Reduced probability of containment failure.	MAB						>$10M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
111	Install additional pressure or leak monitoring instruments for detection of ISLOCAs.	Reduced ISLOCA frequency.	ISLOCA	$123K	$179K	$111K	$154K	$259K	>$500K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
112	Add redundant and diverse limit switches to each containment isolation valve.	Reduced frequency of containment isolation failure and ISLOCAs.	CONT02	$1K	$1K	$1K	$1K	$2K	>$1M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
113	Increase leak testing of valves in ISLOCA paths.	Reduced ISLOCA frequency.	ISLOCA	$123K	$179K	$111K	$154K	$259K	>$1M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
114	Install self-actuating containment isolation valves.	Reduced frequency of isolation failure.	CONT02	$1K	$1K	$1K	$1K	$2K	>$500K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
115	Locate residual heat removal (RHR) inside containment	Reduced frequency of ISLOCA outside containment.	ISLOCA	$123K	$179K	$111K	$154K	$259K	>$1M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.

Table 8-1. Callaway Plant Sensitivity Evaluation

Callaway SAMA Number	Potential Improvement	Discussion	SAMA Case	Benefit	Benefit at 3% Disc Rate	Benefit at Realistic Disc Rate	Benefit at 33yrs	Benefit at 95% CDF	Cost	Cost Basis	Evaluation	Basis for Evaluation
116	Ensure ISLOCA releases are scrubbed. One method is to plug drains in potential break areas so that break point will be covered with water.	Scrubbed ISLOCA releases.	ISLOCA	$123K	$179K	$111K	$154K	$259K	>$1M	Expert Panel	Not Cost-Beneficial	Cost would exceed benefit. Current plant design requires drains to be open. Analysis and license changes required to implement are included in the cost estimate.
119	Institute a maintenance practice to perform a 100% inspection of steam generator tubes during each refueling outage.	Reduced frequency of steam generator tube ruptures.	NOSGTR	$1.4M	$2.1M	$1.2M	$1.8M	$2.9M	>$3M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
121	Increase the pressure capacity of the secondary side so that a steam generator tube rupture would not cause the relief valves to lift.	Eliminates release pathway to the environment following a steam generator tube rupture.	NOSGTR	$1.4M	$2.1M	$1.2M	$1.8M	$2.9M	>$10M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
122	Install a redundant spray system to depressurize the primary system during a steam generator tube rupture	Enhanced depressurization capabilities during steam generator tube rupture.	NOSGTR	$1.4M	$2.1M	$1.2M	$1.8M	$2.9M	>$10M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
125	Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove most of the fission products.	Reduced consequences of a steam generator tube rupture.	NOSGTR	$1.4M	$2.1M	$1.2M	$1.8M	$2.9M	>$10M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
126	Install a highly reliable (closed loop) steam generator shell-side heat removal system that relies on natural circulation and stored water sources	Reduced consequences of a steam generator tube rupture.	NOSGTR	$1.4M	$2.1M	$1.2M	$1.8M	$2.9M	>$10M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
129	Vent main steam safety valves in containment.	Reduced consequences of a steam generator tube rupture.	NOSGTR	$1.4M	$2.1M	$1.2M	$1.8M	$2.9M	>$10M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit. Current containment design does not support this modification. Modifications to containment and associated analysis are included in the cost estimate.
130	Add an independent boron injection system.	Improved availability of boron injection during ATWS.	NOATWS	$63K	$104K	$57K	$90K	$134K	>$1M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.

Table 8-1. Callaway Plant Sensitivity Evaluation

Callaway SAMA Number	Potential Improvement	Discussion	SAMA Case	Benefit	Benefit at 3% Disc Rate	Benefit at Realistic Disc Rate	Benefit at 33yrs	Benefit at 95% CDF	Cost	Cost Basis	Evaluation	Basis for Evaluation
131	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS.	Improved equipment availability after an ATWS.	NOATWS	$63K	$104K	$57K	$90K	$134K	>$2M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
133	Install an ATWS sized filtered containment vent to remove decay heat.	Increased ability to remove reactor heat from ATWS events.	NOATWS	$63K	$104K	$57K	$90K	$134K	>$1M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit
136	Install motor generator set trip breakers in control room.	Reduced frequency of core damage due to an ATWS.	NOATWS	$63K	$104K	$57K	$90K	$134K	>$500K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
147	Install digital large break LOCA protection system.	Reduced probability of a large break LOCA (a leak before break).	LOCA05	$689K	$1.2M	$620K	$1.1M	$1.5M	>$5M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
153	Install secondary side guard pipes up to the main steam isolation valves.	Prevents secondary side depressurization should a steam line break occur upstream of the main steam isolation valves. Also guards against or prevents consequential multiple steam generator tube ruptures following a main steam line break event.	NOSLB	$51K	$87K	$46K	$77K	$108K	>$1M	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
160	Modifications to lessen impact of internal flooding path through Control Building dumbwaiter.	Lower impact of flood that propagates through the dumbwaiter							<$50K	Expert Panel	Potentially Cost-Beneficial	Relatively minor modifications to door opening could result in lower flow to the dumbwaiter. Specific benefit could not be calculated but SAMA item is judged to be low cost and therefore potentially cost beneficial.
161	Improvements to PORV performance that will lower the probability of failure to open.	Decrease in risk due to PORV failing to open.	PORV	$18K	$32K	$16K	$28K	$39K	>$100K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
162	Install a large volume EDG fuel oil tank at an elevation greater than the EDG fuel oil day tanks.	Allows transfer of EDF fuel oil to the EDG day tanks on failure of the fuel oil transfer pumps.	EDGFUEL	$124K	$131K	$113K	$156K	$263K	$150K	Wolf Creek	Potentially Cost-Beneficial	Wolf Creek estimated cost of $150K is less than the potential benefit.
163	Improve feedwater check valve reliability to reduce probability of failure to open.	Lower risk due to failures in which feedwater check valves fail to open and allow feeding of the steam generators.	FW02	$127K	$218K	$115K	$191K	$270K	>$500K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.

Table 8-1. Callaway Plant Sensitivity Evaluation

Callaway SAMA Number	Potential Improvement	Discussion	SAMA Case	Benefit	Benefit at 3% Disc Rate	Benefit at Realistic Disc Rate	Benefit at 33yrs	Benefit at 95% CDF	Cost	Cost Basis	Evaluation	Basis for Evaluation
164	Provide the capability to power the normal service water pumps from AEPS.	Provide backup to ESW in conditions with power only available from AEPS.	SW03	$1191 K	$307K	$172K	$267K	$403K	>$500K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
171	Increase the size of the RWST or otherwise improve the availability of the RWST	Ensure a supply of makeup water is available from the RWST.	LOCA04	$13K	$23K	$12K	$20K	$27K	>$100K	Expert Panel	Not Cost-Beneficial	Cost will exceed benefit.
178	Improvements to UHS cooling tower electrical room HVAC.	Improve availability or mitigate loss of HVAC.	HVAC02	$113K	$181K	$102K	$158K	$239K	<$100K	Expert Panel	Potentially Cost Beneficial	Implementation of temporary ventilation or opening of doors will be a lower cost than the calculated benefit.
179	Modify procedures such that the water loop seals in the RCS cold legs are not cleared following core damage.	Prevents possible thermally induced steam generator tube rupture following core damage.	RAI7a	$63K	$87K	$57K	$75K	$134K	<$100K	Expert Panel	Potentially Cost Beneficial	Implementation of procedure change will be lower cost than benefit, especially if 95% CDF benefit is considered.
180	Install lower amperage fuses for various 14 AWG control circuits in the MCR. The majority of the modification centers around the trip circuit fuses on NB, NG, PA, PB, and PG system breakers.	Reduced fire risk.									Potentially Cost Beneficial	SAMA considered potentially cost beneficial without benefit or cost determination since the NFPA 805 license amendment request committed to performing the modification.
181	Install redundant fuses and isolation switches for MCR evacuation procedure OTO-ZZ-00001.	Reduced fire risk.									Potentially Cost Beneficial	SAMA considered potentially cost beneficial without benefit or cost determination since the NFPA 805 license amendment request committed to performing the modification.

Table 8-1. Callaway Plant Sensitivity Evaluation

Callaway SAMA Number	Potential Improvement	Discussion	SAMA Case	Benefit	Benefit at 3% Disc Rate	Benefit at Realistic Disc Rate	Benefit at 33yrs	Benefit at 95% CDF	Cost	Cost Basis	Evaluation	Basis for Evaluation
182	To protect against multiple spurious operation scenarios, cable runs will be changed to run a single wire in a protected metal jacket such that spurious valve opening due to a hot short affecting the valve control circuit is eliminated for the fire area. This modification will be implemented in multiple fire areas.	Reduced fire risk.									Potentially Cost Beneficial	SAMA considered potentially cost beneficial without benefit or cost determination since the NFPA 805 license amendment request committed to performing the modification.
183	Quick response sprinkler heads in cable chases A-11, C-30, and C-31 will be modified to be in accordance with the applicable requirements of NFPA 13-1976 edition.	Reduced fire risk.									Potentially Cost Beneficial	SAMA considered potentially cost beneficial without benefit or cost determination since the NFPA 805 license amendment request committed to performing the modification.
184	Improvements in the reliability of the Steam Line Isolation automatic signal.	More reliable main steam line isolation.	SLIS	$28K	$40K	$23K	$35K	$55K	>$500K	Expert Panel	Not Cost-Beneficial	Cost is for installation of redundant instrumentation system and would likely be much higher. Procedure and training already direct operators to manually back up failed automatic actuations.
185	Automate initiation of CCW flow to the RHR heat exchangers.	More reliable than manual initiation of flow to RHR HX.	HEP	$62K	$112K	$56K	$99K	$132K	>$200K	Expert Panel	Potentially Cost Beneficial	
186	Develop a procedure and obtain equipment to provide a temporary hookup of fire water to the RHR heat exchangers to use as a backup to CCW for removing decay heat.	Backup method of removing decay heat if CCW is lost.	FWCCW	$1K	$2K	$1K	$2K	$2K	>$1M	Expert Panel	Not Cost Beneficial	Ability to do this will require larger fire pumps
187	Install modification to power the normal charging pump from an existing spare breaker from the AEPS.	Another source of backup power to the NCP in cases of station blackout or loss of service water	SBOMOD	$174K	$272K	$157K	$236K	$367K	$350K	Expert Panel	Potentially Cost Beneficial	Already installed spare circuit breaker, implementation requires power and control cables.

Table 8-1. Callaway Plant Sensitivity Evaluation

Callaway SAMA Number	Potential Improvement	Discussion	SAMA Case	Benefit	Benefit at 3% Disc Rate	Benefit at Realistic Disc Rate	Benefit at 33yrs	Benefit at 95% CDF	Cost	Cost Basis	Evaluation	Basis for Evaluation
188	Install a permanent, dedicated generator for the NCP, and a motor-driven AFW pump and battery charger to address SBO events in which the TD AFW pump is unavailable.	Another source of backup power to the NCP, DC power (pump/valve control and SG level instrumentation), and power to an AFW pump in cases of station blackout or loss of service water	SBOMOD 2	$182K	$285K	$165K	$247K	$385K	$400K	Expert Panel	Potentially Cost Beneficial	AEPS was installed with a spare breaker and expansion capability that could be used to supply various equipment.
189	Perform analysis to determine if it is possible to modify current plant doors to withstand higher flood heights. Either perform modifications to install improved doors or revise flooding analysis to incorporate results that doors will withstand higher flooding heights without propagating the flood.	Reduction in risk due to internal flooding.								Callaway Plant Management	Potentially Cost Beneficial	Installation of modified doors or modification of flooding analysis will result in lower flooding risk. Analysis is currently in progress.

Table 9-1. Callaway Plant Potentially Cost Beneficial SAMAs

Callaway SAMA Number	Potential Improvement	Discussion	Additional Discussion
11	Improve 4.16-kV bus cross-tie ability.	Increased availability of on-site AC power.	Physical cross-tie exists, but there is no analysis or procedures to allow its use except in specific outage conditions. Cost is to develop procedures and analysis to allow use of the cross-tie. Benefit calculated is under-estimated since it was evaluated for only SBO sequences.
29	Provide capability for alternate injection via diesel-driven fire pump.	Improved injection capability.	Currently being evaluated by plant improvement program. Would use unborated water and portable pump (fire truck). Calculation of specific benefit of this SAMA was not performed since it is judged to be potentially low cost. Evaluation will consider impacts of injection of non-borated water.
64	Implement procedure and hardware modifications to allow manual alignment of the fire water system to the component cooling water system, or install a component cooling water header cross-tie.	Improved ability to cool residual heat removal heat exchangers.	Cost based on development of procedure for temporary hookup of fire water to CCW heat exchangers. Cost of permanent modification would be much greater.

Table 9-1. Callaway Plant Potentially Cost Beneficial SAMAs

Callaway SAMA Number	Potential Improvement	Discussion	Additional Discussion
80	Provide a redundant train or means of ventilation.	Increased availability of components dependent on room cooling.	Procedures to open doors or provide temporary ventilation may be cost beneficial for the EDGs, MDAFW pumps, and charging pumps. Procedures for opening doors to the DC switchgear rooms exist.
160	Modifications to lessen impact of internal flooding path through Control Building dumbwaiter.	Lower impact of flood that propagates through the dumbwaiter	
162	Install a large volume EDG fuel oil tank at an elevation greater than the EDG fuel oil day tanks.	Allows transfer of EDG fuel oil to the EDG day tanks on failure of the fuel oil transfer pumps.	
178	Improvements to UHS cooling tower electrical room HVAC.	Improve availability or mitigate loss of HVAC.	Implementation of temporary ventilation or opening of doors will be a lower cost than the calculated benefit.
179	Modify procedures such that the water loop seals in the RCS cold legs are not cleared following core damage.	Prevents possible thermally induced steam generator tube rupture following core damage.	Implementation of procedure change will be lower cost than benefit, especially if 95% CDF benefit is considered.
180	Install lower amperage fuses for various 14 AWG control circuits in the MCR. The majority of the modification centers around the trip circuit fuses on NB, NG, PA, PB, and PG system breakers.	Reduced fire risk.	SAMA considered potentially cost beneficial without benefit or cost determination since the NFPA 805 license amendment request committed to performing the modification.

Table 9-1. Callaway Plant Potentially Cost Beneficial SAMAs

Callaway SAMA Number	Potential Improvement	Discussion	Additional Discussion
181	Install redundant fuses and isolation switches for MCR evacuation procedure OTO-ZZ-00001.	Reduced fire risk.	SAMA considered potentially cost beneficial without benefit or cost determination since the NFPA 805 license amendment request committed to performing the modification.
182	To protect against multiple spurious operation scenarios, cable runs will be changed to run a single wire in a protected metal jacket such that spurious valve opening due to a hot short affecting the valve control circuit is eliminated for the fire area. This modification will be implemented in multiple fire areas.	Reduced fire risk.	SAMA considered potentially cost beneficial without benefit or cost determination since the NFPA 805 license amendment request committed to performing the modification.
183	Quick response sprinkler heads in cable chases A-11, C-30, and C-31 will be modified to be in accordance with the applicable requirements of NFPA 13-1976 edition.	Reduced fire risk.	SAMA considered potentially cost beneficial without benefit or cost determination since the NFPA 805 license amendment request committed to performing the modification.
185	Automate initiation of CCW flow to the RHR heat exchangers.	More reliable than manual initiation of flow to RHR HX.	
187	Install modification to power the normal charging pump from an existing spare breaker from the AEPS.	Another source of backup power to the NCP in cases of station blackout or loss of service water	Already installed spare circuit breaker, implementation requires power and control cables.

Table 9-1. Callaway Plant Potentially Cost Beneficial SAMAs

Callaway SAMA Number	Potential Improvement	Discussion	Additional Discussion
188	Install a permanent, dedicated generator for the NCP, and a motor-driven AFW pump and battery charger to address SBO events in which the TD AFW pump is unavailable.	Another source of backup power to the NCP, DC power (pump/valve control and SG level instrumentation), and power to an AFW pump in cases of station blackout or loss of service water	AEPS was installed with a spare breaker and expansion capability that could be used to supply various equipment.
189	Perform analysis to determine if it is possible to modify current plant doors to withstand higher flood heights. Either perform modifications to install improved doors or revise flooding analysis to incorporate results that doors will withstand higher flooding heights without propagating the flood.	Reduction in risk due to internal flooding.	Installation of modified doors or modification of flooding analysis will result in lower flooding risk. Analysis is currently in progress.