Callaway

Environmental Site SAMA Audit Needs List

Documents requested to be available for review:

1. A21.0027, "Summary Report on the 4B Interim Update of the Callaway PRA," March 2011. Reference 2 from Attachment F of the Callaway Environmental Report.

2. ERIN Engineering and Research, Inc., "Callaway Level 2 Analysis," Rev. 1, April 2011. Reference 24 from Attachment F of the Callaway Environmental Report.

3. Erin Engineering and Research, Inc., "Level 3 PRA Consequence Analysis (MACCS2 Model) for Callaway Sever Accident Mitigation Alternative (SAMA) Evaluation, February 2011. Reference 25 from Attachment F of the Callaway Environmental Report.

4. The Callaway NFPA 805 LAR submittal (particularly Attachments S, U, V, and W)

5. The RAI letter against the LAR submittal dated March 2, 2012 (ML120600186)

6. Any sensitivity studies performed in response to RAIs in which fire CDF and/or LERF have been calculated

7. Any importance analysis performed for the fire PRA

8. The Callaway IPE

9. The source document for the seismic CDF estimate presented in the SAMA analysis

10. The MACCS, MAAP and PRA models to the extent they are needed to answer the audit questions

See Attachment for specific questions to be addressed at the audit. Note that additional questions may be developed and provided prior to the audit.

Interviews

SAMA Interview: Interviews with knowledgeable staff personnel on SAMA and any outstanding questions from review of the site audit needs material. If different than personnel above, interviews with knowledgeable staff on the development of Level 1, 2 and 3 PRA models as well as SAMA identification and evaluation.

Tours

No specific tour will be needed for the SAMA audit.

CALLAWAY SAMA ASSESSMENT

QUESTIONS FOR ENVIRONMENTAL AUDIT

1. Relative to the Level 1 PRA

    a. Table F.3-1 includes a station blackout and a loss of offsite power as initiating event types. Normally, an SBO is a subset of LOSPs as well as other initiators. Similarly ATWS is a subset of other initiators. Explain how the frequency of SBO can be determined separately from other categories and confirm that SBO includes those following LOSP initiator as well as those following other transients. Also ensure that the correct frequencies for each initiator as well as the contribution for SBO and ATWS for all initiators are provided.

    b. The internal events CDF is given as 1.66E-05 per year on page F-11. The CDF for the apparent latest revision, Update 4B, is given as 2.61E-05 per year on page F-20.

        i. Clarify the differences and the basis for that used in the SAMA analysis.

        ii. While this difference may be to be due to exclusion of internal flooding (9.14E-06 in Table 3-4) from the 1.66E-05 value and inclusion of it in the external events multiplier, adding this value for internal floods to the Table 3-1 value yields 2.57E-05, which is close but not equal to the 2.61E-05 value. If the difference is due to the exclusion of internal floods, provide justification of why this was done and discuss the impact on the SAMA analysis. Note that the first and third PRA updates included revisions to the internal flooding analysis.

        iii. Provide support for the validity of the importance analysis used for plant specific SAMA identification which excludes internal flooding.

    c. Provide the truncation value used for each PRA.

    d. Provide further discussion of the steps taken to insure the technical adequacy of the Level 1 PRA subsequent to the 2000 WOG peer review. Specifically address:

        i. Further support for the disposition of peer review F&Os IE-7 and ST-1 as described in Table 3-8 of the SAMA submittal.

        ii. A description of the findings of the 2006 review against the 2005 revision of the ASME PRA standard and the disposition of any deficiencies for the SAMA application. Attachment U of the NFPA 805 Licensing Amendment

Request (LAR) provides this information relative to the fire risk application. Similar information is needed for the SAMA application.

iii. We understand from Attachment U of the NFPA 805 LAR submittal that the internal events PRA Human Reliability Analysis (HAR) modeling has been revised and undergone a focused scope peer review. This peer review is not discussed in the SAMA submittal. Discuss the scope, findings and disposition of those findings.

e. As a result of NRC review of Callaway's NFPA 805 submittal NRC has requested the results of sensitivity analyses to show the impact of potentially unacceptable modeling approaches (see PRA RAI-08 on influence weighting factors and PRA RAI-09 on control power transformer credit). Provide the impact of these sensitivity analyses on the calculated fire CDF and then show the impact of these higher fire CDFs on the SAMA analysis.

f. The description of PRA Update 4B mentions the Alternate Emergency Power System (AEPS) modification. Describe this modification and the temporary EDG modification mentioned for PRA Update 4A.

g. What was the freeze date for PRA Update 4B and have there been any changes to the plant, either physical or procedural, since that date that could have a significant impact on the results?

2. Relative to the Level 2 PRA

a. The 5th bullet in Section F.3.2 states that the sequences that contribute to LERF were determined based on source term calculations using MAAP 4.0.7. What was the basis for the source terms for the other release categories?

b. The last paragraph in Section F.3.2 states: "There were no changes to major modeling assumptions, containment event tree structure, accident progression, source term calculations or other Level 2 attributes, used in the IPE Level 2 analysis, when developing the initial and updated models." Discuss this statement in light of the many apparent changes discussed previously in this section and in the disposition of the Level 2 Peer Review F&Os in Table F.3-8.

c. Provide a description of the containment event tree or trees (CET) used in the level 2 analysis including a listing and description of the CET nodes. Include description of how phenomenological events and containment system failures are addressed in the CET.

d. Section F.3.4 identifies 8 release categories. Provide further information on each release category including: category definitions and their bases, how the CET end states are assigned to release categories, a description of the sequences that are the major contributors to each release category, the basis for the selection of MAAP case used for each release category, and a description of the MAAP cases used. 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.

e. Provide a discussion of the steps taken to insure the technical adequacy of the Level 2 PRA.

3. Relative to external events:

   a. Section F.3.1.2.2 states that:

      > "For the IPEEE, Callaway used the EPRI seismic margins analysis (SMA) method. This analysis was transmitted to NRC in the IPEEE submittal. The latest estimate of the Callaway seismic contribution to CDF is 5.00E-6/yr."

      A SMA does not normally include an estimate of seismic CDF. What is the source and basis for the 5.00E-6/yr value?

   b. Section F.3.1.2.3 states that the risk for tornado events is 2.5E-05/yr and this is considered a contributor to the external events initiator group for calculating the external events multiplier.

      i. Provide the basis for this value.

      ii. Identify SAMAs to mitigate the contribution this makes to the total CDF.

4. Relative to the Level 3 analysis

   a. Tables F.3-9 and 3-10 provide the year 2044 population distribution used in the MACCS2 analysis. Provide the year 2000 population distribution (Table 2.6-1 provides only a partial breakdown).

   b. Section F.3.4.1 identifies that the population was projected to year 2044 using county growth estimates. Briefly describe how the county growth rates were applied (e.g. county weighted per sector, or state average uniformly applied across all sectors, other). Were any sectors/counties projected with negative growth, if yes, how were they treated.

   c. Section F.3.4.1 identifies that transient population data was included within the 10-mile radius. Provide the year 2000 transient population, and identify whether the transient population was scaled to year 2044. Briefly discuss how the transient population was included within the 10-mile radius.

   d. Section F.3.4.2 identifies that some generic economic data was used from NUREG-1150, and scaled using the CPI to May 2010. Provide the effective cost escalation factor applied.

   e. Three SECPOP2000 code errors have been publicized, specifically: 1) incorrect column formatting of the output file, 2) incorrect 1997 economic database file end character resulting in the selection of data from wrong counties, and 3) gaps in the 1997 economic database numbering scheme resulting in the selection of

data from wrong counties. Address whether these errors were corrected in the Callaway analysis. If they were not corrected, then provide a revised cost-benefit evaluation of each SAMA with the errors corrected.

f. The emergency response sensitivity shows a +7% change for slower evacuation and a +2.4% change for delayed evacuation. Is the higher impact for evacuation speed due to unsheltered travel and/or exposure to 'higher' initial dose releases versus early sheltering and lower delayed releases?

g. Provide the MAAP and MACCS2 (if different than MAAP) radioisotope grouping, and identify the release time for early versus late release.

h. Identify the specific reference for the Callaway Evacuation Study. Discuss whether and how the evacuation time was adjusted for the difference in population between year 2045 and the year of the referenced evacuation time estimate study. If not, briefly discuss the potential impact to the SAMA evaluation. Identify whether the EPZ was treated as a single evacuation zone.

i. Section F.3.4.5 indicates that the year 2008 meteorological data was more conservative than years 2007 and 2009. Briefly quantify the relative conservatism and identify of the tower heights (i.e. potential range of measurement elevations) for the onsite meteorology station and at the Prairie Fork Conservation.

j. Briefly describe additional MACCS2 input related to the following: rainfall, mixing heights, building wake effects, plume release energy, land fraction, region index, watershed index, growing season, fraction of farmland, and shielding and protection factors.

k. Table 3-15 provides ingestion doses. Briefly describe the model (e.g. the MACCS2 ingestion pathway model COMIDA2).

5. Relative to the selection and screening of Phase I SAMA candidates:

a. Table F.5-1 shows that while 6 out of the 171 SAMA candidates identified are plant-specific SAMAs identified from plant-specific risk insights, it appears that the fire PRA for the recently submitted NFPA 805 LAR was not used as a source to generate plant-specific risk insights. Table F.3-4 shows that the external event contribution to total CDF is greater (e.g., fire CDF is 2.0E-5/yr) than the internal events contribution (i.e., internal CDF is 1.7E-05/yr). Provide identification and evaluation of SAMAs based on plant specific insights from the post-transition fire PRA. Include as part of this identification consideration of fire PRA importance analysis, the dominant risk fire areas and associated sequences, and the risk of modifications that Callaway Plant has committed to. Also, describe how this information was used to identify SAMA candidates and evaluate any resulting SAMA candidates not already evaluated.

b. Section F.3.1.2.3 states the internal events PRA does not include internal flooding modeling. However, Section F.3.1.1.2 indicates that internal flooding was included in the IPE and in a PRA update as recently as 2004. Discuss the results of

applicable internal flooding analysis and potential internal flooding SAMAs based on internal event flooding.

c. Section F.5.2 states that potential enhancements identified in the IPE were included in Table F.5-1. Only 4 of the 5 enhancements identified in IPE Section 6.2.1, "Plant Improvements to be Implemented" are included in Table F.5-1 and none of the 5 enhancements in Section 6.2.2, "Plant Improvements to be Considered" were included. Provide the status and an evaluation of:

   i. The missing improvement from IPE Section 6.2.1, 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, and

   ii. the five improvements listed in IPE Section 6.2.2

d. Note 1 to Table F.3-2 states, "The current plant procedures and training meet current industry standards. There are no additional specific procedure improvements that could be identified that would affect the result of the human error probability (HEP) calculations. Therefore, no SAMA items were added to the plant specific list of SAMAs as a result of the human actions on the list of basic events with RRW greater than 1.005." This appears to imply that meeting current industry standards is sufficient to indicate that no additional SAMAs are needed.

   i. Provide support for that belief.

   ii. Explain the process used to make the determination that there are no opportunities to improve procedures and training. Include in the explanation how human error probability factors were considered (e.g., cognition, resources, timing, and stress level).

   iii. Discuss whether any of the risk significant operator action failures could be addressed by options other than training or procedures such as automated functions, testing and maintenance to reduce failure or event rates, or enhanced documentation. Specifically discuss the potential for automating the function associated with basic event OP-XHE-FOCCWRHX (OPERATOR FAILS TO INITIATE CCW FLOW TO THE RHR HXS) identified in Table 3-2.

e. In Tables 3-2, 3-6 and 3-7 the SAMAs associated with the various basic events in many cases are identified by generic titles such as "Service Water SAMAs" or "Safety Injection SAMAs" rather than site specific SAMAs that address the failure associated with the basic event. Also, these SAMA categories do not correlate to SAMA categories identified in Table 5-1. For example the categories “Service Water SAMAs" and "Safety Injection SAMAs" are not identified in the fourth column of Table 5-1. In light of this and the fact that only three SAMAs are identified in Table F.5-1 as a result of the importance analysis it is not clear the extent of the effort made to identify Callaway specific SAMAs for the important failures. Describe in more detail than provided in Section F.5.1 how the importance analysis was used to identify plant specific SAMAs. Revise Tables 3-2, 3-6, and 3-7 to indicate

which SAMAs address each specific basic event by providing the SAMA number or numbers.

f. In importance analyses Tables F.2-3, 3-6 and 3-7 some basic events are not assigned a candidate SAMA but rather with the notation that they are initiating events (i.e., IE-T3, IE-TMSO, IE-S3, IE-T2). Identify SAMAs for these initiating events that either reduce their frequency or mitigate their impact.

g. In Table 3-6 four basic events involving failure of a relay to transfer are presented and designated to be addressed by SAMA 79. SAMA 79 is replacement of existing pilot-operated relief valves with larger ones so that only one is needed to open for feed and bleed. Explain how this SAMA addresses relay failure to transfer.

h. Table F.6-1 indicates that SAMA 3 (Add additional battery charger or portable diesel-driven battery charger to existing DC system) is screened out on the basis that the intent of this SAMA is met by having 2 spare battery chargers. This SAMA also includes a diesel driven charger. Does Callaway have such equipment available?

i. Provide further information on the disposition (Replaced to add static switch and upgrade to newer design) of SAMA 16 (Improve uninterruptible power supplies) in Table 6-1.

j. Is the remote operation of the atmospheric steam dumps (ASDs) cited in the disposition of SAMA 40 in Table 6-1 functional in an SBO as is required for this SAMA?

k. In Table F.6-1 SAMAs 81, 82 and 83 were screened on the basis that the intent of these HVAC SAMAs was met at Callaway. Was the intent of these SAMAs met for all Callaway rooms or areas where room cooling failures are important contributors to CDF?

l. In Table F.6-1 SAMA 137 (Provide capability to remove power from the bus powering the control rods) is dispositioned with "Response procedure in place." Does this procedure include removing power from the bus powering the control rods?

m. In Table F.6-1 SAMA candidate 138 (Improve inspection of rubber expansion points on main condenser) is screened out as “Not Applicable” with the disposition that “No risk significant flooding sources identified in the turbine building.” Although the current internal events PRA is stated not to include analysis of internal flooding, the Callaway IPE indicates that internal flooding contributed 31% to internal events CDF. Clarify how the risk significance of flooding sources in the turbine building was determined. If flooding sources can be risk significant identify and evaluate applicable SAMAs.

n. In Table F.6-1 SAMA 141 (Provide additional restraints for CO_2 tanks) is combined with other seismic SAMAs (i.e., 154, 155, 156, 157, 158, and

159). None of these SAMAs address this specific issue. Are the CO_2 tanks vulnerable and need additional restraint?

o. In Table F.6-1 SAMA candidate 144 (Install additional transfer and isolation switches) for reducing the potential for spurious actuation during a fire is screened out as "Intent Met" based on modification commitments made in the NFPA 805 LAR submittal. NFPA 805 LAR, Attachment S, does identify such an item (i.e., Item 07-0151 - Install redundant fuses and switches to prevent multiple spurious actions from stopping or starting safety equipment). However, this modification is specific to selected cables in the Main Control Room to Train B fed from NB02. Justify or evaluate other modifications that would reduce spurious actuations during a fire.

6. With regard to the Phase II cost-benefit evaluations:

a. Provide the percent reduction in OECR for each SAMA evaluated in Table F.7-1 and any other SAMAs evaluated in response to RAIs.

b. ER Section F.7.2 indicates that an expert panel developed the implementation cost estimates for each of the SAMAs. Briefly, describe the level of detail used to develop the cost estimates (i.e., the general cost categories considered). Also, clarify whether the cost estimates accounted for inflation, contingency costs associated with unforeseen implementation obstacles, replacement power during extended outages required to implement the modifications, and maintenance and surveillance costs during plant operation.

c. For certain Phase II SAMAs listed in Table F.7-1, the information provided does not sufficiently describe the associated modifications to know what is included that justifies the cost estimate. Provide a more detailed description of both the modification and cost estimate for SAMAs 11, 15, 64, 94, 104, 116, 163, and 164.

d. For certain Phase II SAMAs listed in Table F.7-1, the calculated benefit does not seem consistent with the percent reduction in CDF or off-site dose or there was no CDF or off-site dose information to compare to the calculated benefit. Provide corrections or more justification for the benefit calculated for SAMAs 39, 160, 161, 162, 163, 164, and 171.

e. In Table 7-1, SAMA 1 (add additional DC battery capacity) is evaluated by eliminating TDAFW pump dependency on DC power while SAMA 2 (replace lead-acid batteries with fuel cells) is evaluated by eliminating all SBO. For SAMA 1 (and SAMA 5 - provide DC buss cross ties also evaluated by eliminating the TDAFW pump DC dependency) is the TDAFW pump availability the only impact of the loss of DC? Both SAMAs 1 and 2 extend DC power availability during SBO. Explain the reasons for the difference evaluations that do the same thing.

f. In Table 7-1 the reduction in CDF for SAMA 2 is given as 12.17%. This is evaluated as eliminating SBO events. Table F.3-1 presents a value for SBO that is 28% of the total. Explain this difference.

g. SAMA 15 is evaluated by SAMA case LOSP1 which is described as leading to no tornado LOSP events. Provide additional information on the model changes made and their applicability to this SAMA. Also, does Callaway already have a gas-turbine?

h. In Table F.7-1 SAMA 24 (Bury off-site power lines) is shown as costing >$3M, and as not being cost beneficial. However, the potential benefit of this SAMA is high ($1.2M) and the estimated cost of this SAMA reported in the Seabrook ER (a recent Westinghouse PWR-4 submittal) is lower (>$1M). (In the South Texas, Diablo Canyon, or Salem ERs, this SAMA was not evaluated as a Phase II SAMA.) Provide a more detailed description of this modification and justification for the estimated cost.

i. Provide additional information on the changes made for SAMA Case LOCA12 used to evaluate SAMAs 25, 26 and 39. What modeling change was made to eliminate failures of the charging or SI pumps. Were the assumed failures limited to LOCAs or did they include failure due to loss of AC?

j. Provide additional information on the changes made for SAMA Case LOCA03 used to evaluate SAMA 28. What modeling change was made to eliminate failures of the low pressure pumps. Were the assumed failures limited to LOCAs or did they include failure due to loss of AC?

k. Table F.7-1 indicates that the expert panel judged SAMA 29 to be potentially cost beneficial without quantifying a benefit or cost. ER Section 9.0 indicates that SAMA 29 is currently being evaluated to understand the impacts of injection of non-borated water. Provide estimation of the cost and benefit based on the results of this evaluation

l. In Table F.7-1 benefit for SAMA 39 given as $748K. Obviously an error. See SAMA 25.

m. Table F.7-1 indicates that SAMA 46 (Add a service water pump) was modeled by assuming there were no failures of ESW pumps. Does this include ESW pump unavailability due to test and maintenance?

n. Phase II SAMAs 55 and 56 listed in Table F.7-1 appear to be identical except for the cost estimates (i.e., $1M versus >$500K). Provide correction or explanation.

o. In Table F.7-1 SAMA 94 (Install a filtered containment vent to remove decay heat) is shown as >$2M, and as not being cost beneficial. However, the potential benefit of this SAMA is high ($1.2M) and the estimated cost of this SAMA reported in the Seabrook ER is lower (>$500K). (In the South Texas, Diablo Canyon, or Salem ERs, this SAMA was not evaluated as a Phase II SAMA.) Provide a more detailed description of this modification and justification for the estimated cost.

p. In Table F.7-1 SAMA 113 (Increase leak testing of valves in ISLOCA paths) is shown as costing >$1M, and as not being cost beneficial. However, the potential benefit of this SAMA is moderate ($123K), and the cost of this SAMA, as it does not require hardware modification seems high. The Seabrook ER reports and

estimated cost of >$100K for this SAMA. (In the South Texas, Diablo Canyon, or Salem ERs, this SAMA was not evaluated as a Phase II SAMA.) Provide a more detailed description of this modification and justification for the estimated cost.

q. In Table F.7-1 SAMA 119 (Institute a maintenance practice to perform a 100% inspection of steam generator tubes during each refueling outage) as costing >$3M, and as not being cost beneficial. However, the potential benefit of this SAMA is high ($1.2M), and the cost of this SAMA, as it does not require hardware modification seems high. The Seabrook ER reports and estimated cost of >$500K for this SAMA. (In the South Texas, Diablo Canyon, or Salem ERs, this SAMA was not evaluated as a Phase II SAMA.) Provide a more detailed description of this modification and justification for the estimated cost.

r. Table F.7-1 in combination with Table F.5-1indicates that the expert panel judged SAMA 160 to be potentially cost beneficial without quantifying a benefit. Although the current internal events PRA is stated not to include analysis of internal flooding, Section 3.1.1.2 indicates that the internal events flooding PRA model did exist in the IPE and was updated as recently as 2004. Provide estimation using the best means available the benefit of SAMA 160.

s. Describe the RCP seal LOCA modeling in the Callaway PRA and the changes made for Case RCPLOCA.

t. Section F.8.2 indicates that the uncertainty factor used for the ratio of the 95th to mean value CDF is 2.11. In Table F.8-1 the ratio of the base case benefit to the 95th percentile case for SAMAs 91, 93, and 94 appears to be low (i.e., 1.4). Explain this apparent discrepancy or if this is a mistake recalculate the 95th percentile benefit for these three SAMAs.

7. With regard to alternative SAMAs

a. A note at the end of Table F.5-1 indicates that recent industry submittals of like-kind plants (i.e., Wolf Creek, South Texas, Diablo Canyon, and Seabrook) were used as a source of candidate SAMAs. It is not clear the extent to which these submittals were examined, as only two SAMA candidates were identified in Table F.5-1 as being from these sources (i.e., SAMA 162 and 165). Also, it appears that a cost beneficial SAMA identified in the Diablo Canyon submittal might represent an unevaluated SAMA candidate for Callaway (i.e., SAMA 24 – Prevent clearing of RCS cold leg water seals). Describe the extent to which the four cited SAMA submittals were used as sources to generate candidate SAMAs, and evaluate each SAMA determined to be cost beneficial in those submittals or show how they could be screened out using criteria presented in ER Section F.6.0

b. SAMA 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) is evaluated by eliminating CCW pump failures. Consider a similar SAMA that provides fire water to the ESW system.

c. SAMA 80 (Provide a redundant train or means of ventilation) appears to be the only SAMA identified to address the eleven HVAC related failures in Table 3-2. Table 7-1

indicates that elimination of all HVAC dependencies for SAMA 80 results in a 6% reduction in CDF. The individual HVAC failures listed in Table 3-2 appear to involve unrelated pieces of equipment in various rooms or buildings. Discuss the possibility of lower cost alternatives that address the more important contributors to CDF. Note that two of the above cited failures (VD-FAN-FR-CGD02A and -CGD02B) appear to be the reason for SAMA Case HVAC02 described on Page F-109. This case is not used in the Phase II analyses described in Table 7-1.