F. Fire-Induced Multiple Spurious Operations Resolution

5 Pages Attached

MSO Process Summary

The following steps are in accordance with guidance provided in FAQ 07-0038 Revision 3 (ML110140242), along with the application of that process and the results.

Step 1 – Identify potential MSOs of concern

Information sources that may be used as input include:

- Post-fire safe shutdown analysis (NEI 00-01, Revision 1, Chapter 3)
- Generic lists of MSOs (e.g., from Owners Groups and/or later versions of NEI 00-01, if endorsed by NRC for use in assessing MSOs)
- Self assessment results (e.g., NEI 04-06 assessments performed to addressed RIS 2004-03)
- PRA insights (e.g., NEI 00-01 Revision 1, Appendix F)
- Operating Experience (e.g., licensee event reports, NRC Inspection Findings, etc.)

Results of Step 1:

The Callaway Plant MSO identification process started with an extensive review of plant systems and drawings to determine potential pathways. The initial review was conducted using the existing models and engineering documentation to identify functional failure paths that would be important to risk. This initial review was then supplemented by generic industry lists. The following data sources were used as input to the overall assessment of MSOs at Callaway Plant. The Callaway plant MSO identification process resulted in a list of potential MSO pathways for consideration by the MSO Expert Panel.

- Callaway Plant Calculation No. 17671-0002, “Fire PRA Component Selection” and the associated Component Selection Task Plan
- Callaway Plant Calculation No. KC-26, “Nuclear Safety Capability Assessment”
- PWROG Generic MSO List (WCAP-16933-NP)
- Miscellaneous operating experience
- PRA Insights from the Internal Events PRA (1Q08-MSPI model of record)

Step 2 – Conduct an expert panel to assess plant specific vulnerabilities (e.g., per NEI 00-01, Rev. 1 Section F.4.2).

The expert panel should focus on system and component interactions that could impact nuclear safety. This information will be used in later tasks to identify cables and potential locations where vulnerabilities could exist.

The documentation of the results of the expert panel should include how the expert panel was conducted including the members of the expert panel, their experience, education, and areas of expertise. The documentation should include the list of MSOs reviewed as well as the source for each MSO. This documentation should provide a list of the MSOs that were included in the PRA and a separate list of MSOs that were not kept for further analysis (and the reasons for rejecting these MSOs for further analysis).

Describe the expert panel process (e.g., when it was held, what training was provided to the panel members, what analyses were reviewed to identify MSOs, how was consensus achieved

on which MSOs to keep and any dispute resolution process criteria used in decision process, etc.)

[Note: The physical location of the cables of concern (e.g., fire zone/area routing of the identified MSO cables), if known, may be used at this step in the process to focus the scope of the detailed review in further steps].

Results of Step 2:

An initial MSO Expert Panel was conducted at Callaway Plant in July 2007. A training session for the panel members was conducted prior to starting the actual assessment and the expert panel followed a project instruction. The results of the MSO Expert Panel were documented in Callaway Plant Calculation 17671-002b, "Multiple Spurious Operation Expert Panel." The calculation also includes:

- The project instruction that was used as the training materials
- The qualifications (i.e., education, experience, and areas of expertise) for each of the MSO Expert Panel participants
- A list of the MSOs that were reviewed
- The source of the MSOs that were reviewed (i.e., industry list, plant-specific, "what if" review)

The results of the MSO Expert Panel were integrated into the NFPA 805 NSCA, Callaway Plant Calculation KC-26, "Nuclear Safety Capability Assessment" and provided as input into the Fire PRA development, Callaway Plant Calculation 17671-0004, "Fire PRA Fire Induced Risk Model."

A second MSO Expert Panel assessment was conducted at Callaway Plant in January 2008. The second MSO expert panel discussed and dispositioned open items from the original MSO Expert Panel and addressed new generic MSOs that had been identified since the first panel. The results of the second panel assessment were documented in an update to the original calculation. Then, in October 2009 the MSO expert panel report was reviewed by the PWR OG Peer Review team, and updated to include the generic MSO list from WCAP-16933-NP that had been released in April 2009. The June 2010 update to the generic WCAP list (revision 1) was reviewed in April 2011 and changes in the generic MSO Expert Panel list were incorporated into the current Callaway MSO Expert Panel report. The Callaway MSO Expert Panel report describes the processes used to achieve consensus and to establish the basis for MSO rejection. The final product of this step was a report that assessed the MSO pathways that apply to the Callaway Plant.

Step 3 – Update the Fire PRA model and NSCA to include the MSOs of concern

This step includes the:

- Identification of equipment (NUREG/CR-6850 Task 2)
- Identification of cables that, if damaged by fire, could result in the spurious operation (NUREG/CR-6850 Task 3, Task 9)
- Identify routing of the cables identified above, including associating that routing with fire areas, fire zones and/or Fire PRA physical analysis, as applicable.

The MSOs include the equipment/cables of concern in the Nuclear Safety Capability Assessment (NSCA). Including the equipment and cable information in the NSCA does not

necessarily imply that the interaction is possible since separation/protection may exist throughout the plant fire areas such that the interaction is not possible).

Results of Step 3:

The results of the expert panel were included in the component selection report (17671-002a associated with NUREG/CR-6850 Task 2) of the Callaway Plant Fire PRA. The Callaway Plant component selection report identified components associated with spurious operations, including multiple spurious operations, based on the NSCA and the MSO expert panel review. The Callaway Plant fire-induced risk model (17671-0004 associated with NUREG/CR-6850 Task 5) of the Callaway Plant Fire PRA was then modified to explicitly model those MSO pathways that apply to the Callaway plant as identified in MSO Steps 1 and 2.

The results of the fire PRA model update are included in the following calculations and engineering analyses:

- Callaway Plant Calculation No. 17671-002a, “Fire PRA Component Selection”
- Callaway Plant Calculation No. R1843-004-003, “Fire PRA Cable Selection-Cable Location”
- Callaway Plant Calculation No. 17671-0004, “Fire PRA Fire-Induced Risk Model”
- Callaway Plant Calculation No. P1843-004-008, “Detailed Circuit Failure Analysis”

These calculations and engineering analyses include:

- Correlation of safe shutdown components and PRA basic events,
- Logic changes made to the Fire PRA model to account for MSO scenarios relevant to fire but not already captured by the Internal Events PRA

The MSO combinations of components of concern were then evaluated for inclusion into the Callaway Plant NSCA model. As necessary, components were added to the NSCA Equipment List and Logics; and circuit analysis and cable routing was performed. The results are documented in Callaway Plant Calculation No. KC-26, “Nuclear Safety Capability Assessment.”

[Note: Instances existed where conditions associated with MSOs did not require update of the Fire PRA and NSCA analysis. For example, Fire PRA analysis performed in accordance with NUREG/CR-6850 Task 2, Component Selection, determined that the particular interaction would not lead to core damage, or pre-existing equipment and cable routing information determined that the particular MSO interaction was not physically possible. In other instances, update of the Fire PRA was not warranted since the contribution was negligible. The rationale for exclusion of identified MSOs from the Fire PRA and NSCA was documented in Callaway Plant Calculation 17671-002b, “MSO Expert Panel Report” and Callaway Plant Calculation No. KC-26, “Nuclear Safety Capability Assessment,” respectively. Configuration control mechanisms will be reviewed to provide reasonable confidence that the exclusion basis remains valid, as detailed in Attachment S (Implementation Item 11-805-088).]

Step 4 – Evaluate for NFPA 805 Compliance

The MSO combinations included in the NSCA should be evaluated with respect to compliance with the deterministic requirements of NFPA 805, as discussed in Section 4.2.3 of NFPA 805. For those situations in which the MSO combination does not meet the deterministic requirements of NFPA 805 (i.e., a VFDR), the issue with the components and associated cables was mitigated by other means (e.g., performance-based approach per Section 4.2.4 of NFPA 805, plant modification, etc.)

The performance-based approach may include the use of feasible and reliable recovery actions. The use of recovery actions to demonstrate the availability of a success path for the nuclear safety performance criteria requires that the additional risk presented by the use of these recovery actions be evaluated (NFPA 805 Section 4.2.4).

Results of Step 4:

The Callaway Plant fire PRA quantified the fire-induced risk model containing the MSO pathways. The quantification addressed the specific electrical cables and the failure mode in each fire area and fire zone that was quantified. Thus, the MSO contribution is included in the fire PRA results, and in the fire PRA results associated with evaluation of VFDRs as documented in applicable fire risk evaluations.

The MSO combination of components of concern were also evaluated as part of the Callaway Plant NSCA (i.e., Callaway Plant Calculation No. KC-26, "Nuclear Safety Capability Assessment"). For cases where the MSO combination of components did not meet the requirements for deterministic compliance, the MSO combination of components were identified as VFDRs and added to the scope of the fire risk evaluations.

The process and results associated with the performance of fire risk evaluations are summarized in Section 4.5 of the Transition Report.

Step 5 - Document Results

The results of the process have been documented. The results provide a detailed description of the MSO identification, analysis, disposition, and evaluation results (e.g., references used to identify MSOs; the composition of the expert panel, the expert panel process, and the results of the expert panel process; disposition and evaluation results for each MSO, etc.).

Results of Step 5:

The MSO process and results are documented in the following calculation files and reports:

- Callaway Plant Calculation No. 17671-0002, "Fire PRA Component Selection"
- Callaway Plant Report No. 17671-0002b, "Multiple Spurious Operations Expert Panel Report"
- Callaway Plant Report R1843-004-003, "Fire PRA Cable Selection-Cable Location"
- Callaway Plant Calculation No. KC-26, "Nuclear Safety Capability Assessment"
- Callaway Plant Calculation No. FIRE-17671-0004, "Fire PRA Fire Induced Risk Model"
- Callaway Plant Calculation P1843-004-008, "Detailed Circuit Failure Analysis"

These calculations and engineering analyses include:

- Correlation of PRA basic events and safe shutdown components
- A listing of MSOs considered with documentation of their disposition
- Logic Changes made to the Fire PRA model to account for MSO scenarios relevant to fire but not already captured by the Internal Events PRA
- MSO combination of components added to the NSCA Equipment List and Logics as appropriate; and circuit analysis and cable routing performed.

Additionally, spurious actuation failure probabilities are documented in the circuit failure likelihood report. The quantification of individual areas, the Main Control Room and multi-compartment analyses is documented in three separate reports.

Summary of Results and Risk Insights

As part of Step 4 of the process outlined above, MSO combinations were reviewed for their impact on deterministic compliance (i.e., fire area reviews to determine if the same fire could result in the potential MSO combinations). As part of the process, VFDRs were created where the deterministic requirements of NFPA 805 Section 4.2.3 were not met. These VFDRs were addressed by demonstrating compliance with the performance-based approach of Section 4.2.4 of NFPA 805 (See Section 4.5 and Attachment C of this document).

Note that the spurious operations reviewed as part of the process included components that were part of the original Callaway Plant 10 CFR 50 Appendix R post-fire safe shutdown analysis, as well as components and interactions that were added following a plant-specific review of functional failures and evolved industry issues. No specific distinction is made in the program documentation whether the interaction is related to a single spurious operation or MSO, since the risk-informed approach using the Fire PRA provides an integrated plant response model.

In addition to the process defined above, another review was performed to gain risk insights related to fire-induced MSOs.

Spurious operations, both single and multiple, have an impact on the overall fire risk and are included in the fire PRA model. Fire-induced spurious operations generating a control signal that can lead to initiating events (e.g., PORV(s) transferring open) and can also affect mitigation of initiators such as AFW supplying the steam generators or SG ASD (Atmospheric Steam Dump Valves) isolation used for relieving pressure. Given the potential significance of fire-induced MSOs, an expert panel was held at Callaway Plant to systematically search for and identify MSO failures not already captured by the Internal Events PRA model, which was used as the starting point for the fire PRA. Logic modifications were made in the fire PRA (3Q09-FPRA) to incorporate several fire-induced MSO-related failures not already captured by the base model.

Fire-induced MSOs are included in the fire PRA model, and their associated risk is included in the quantification of each fire scenario, the total plant fire risk, and evaluation of each VFDR. The VFDRs are identified in Attachment C, Table B-3 and a summary of the Fire PRA results is provided in Attachment W.