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Importance of RWT Drain Down Scenario due to MSO during a Fire

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1. Introduction

The fire hazard analyses (FHA) for nuclear power plant have been based on the basic assumption that when the spurious operation of equipment occurs, then it would occur one at a time basis. However, recent cable fire tests and fire case investigations reveal that the possibility of spurious operations involving two or more equipment would not be so small to be ignored. Therefore it is urgent to introduce the multiple spurious operations (MSO) into FHA and to implement the measures against to those MSOs resulting in degradation of safe shutdown operation after a fire. In this paper, importance of RWT depletion scenario resulting from MSO is discussed.

2. Method of MSO analysis

US NRC endorses NEI00-01 as acceptable method for analyzing the MSO during a fire in nuclear power plant [1,2]. Figure 1 represents MSO flowchart described in NEI00-01. The first step is to prepare plant specific MSO list by combining applicable generic MSO list and newly defined MSO scenarios by expert panel review. Next step is to define fire compartments that each MSO scenario is induced under a fire, by analyzing the equipment and cable information database involved in each MSO scenario. Finally, for each fire compartment that a specific MSO scenario resulting in degradation of safe shutdown operation after a fire will occur by a fire damage, countermeasure for preventing or mitigating the MSO scenario should be established.

If the equipment involved in MSO scenario are those required for safe shutdown, the countermeasures should be such that redundant success paths satisfy the deterministic separation criteria. If the MSO equipment are in the category of those important to safe shutdown, the countermeasures should be either deterministic compliance methods or performance based methods such as operator manual action (OMA), fire modeling, or fire PSA.

3. Importance of RWT depletion scenario

Figure 2 depicts the containment spray system drawing for typical nuclear power plant. This system is one of the engineered safety feature systems that, under design basis accident in the reactor containment such as the loss of coolant accident, main steam line break, or main feedwater line break, remove the heat and fission products and mitigate the containment pressure and temperature within acceptable environmental condition.

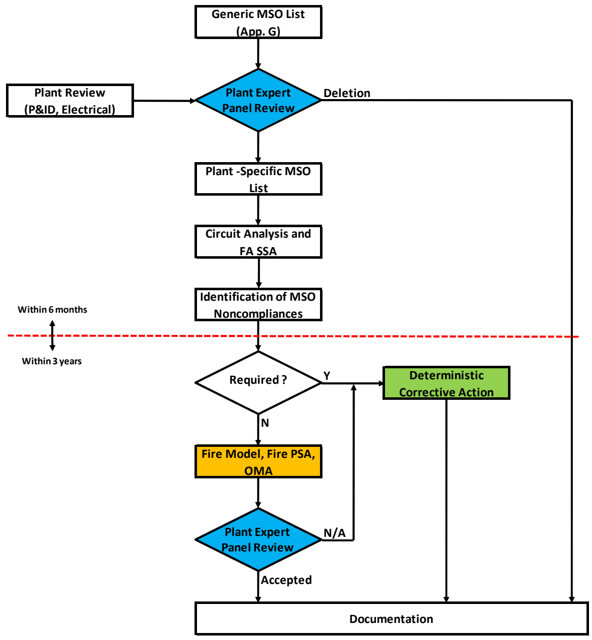

Figure 1 Procedure for Analyzing Multiple Spurious Operation

If a fire within the plant area results in spurious containment spray signal due to control circuit damage or concurrent spurious actuation of the containment spray pump and discharge valve, boric acid in the refueling water tank (RWT) would be discharged into the containment which could lead to depletion of the boric acid used for reactivity control and primary inventory control during safe shutdown operation. In this scenario, safe shutdown operation will be threatened by the loss of reactivity control and inventory control functions. This scenario is very likely because MSO occurred in only one train out of two trains of the system will sufficiently lead to adverse impact to the safe shutdown function. The control cables of the containment spray pump and associated discharge valve in same train of either A or B, are likely routed through same compartments, thus a fire in one compartment out of those compartments may lead to this MSO scenario. Because RWT is classified to equipment important to safety, the performance based methods such as operator manual action (OMA), fire modeling, or fire PSA can be applied to the resolution of this MSO noncompliance instead of deterministic compliance methods.

When the operator manual action is applied to the resolution of this MSO scenario, then the time margin for this action would be the critical feasibility factor. Since the plant RWT inventory is 600,000 gallons and the capacity of one containment spray pump is maximum 5,000gpm, RWT depletion time for this MSO scenario is calculated 600,000/5,000=120min. The feasibility and reliability of this operator manual action should be demonstrated by showing that the action is sufficiently accomplished within this 120minute time window. In addition to the time margin for this action, tools needed to this manual action, qualified personnel, local accessibility, relevant procedures, and sufficient indications should be also demonstrated.

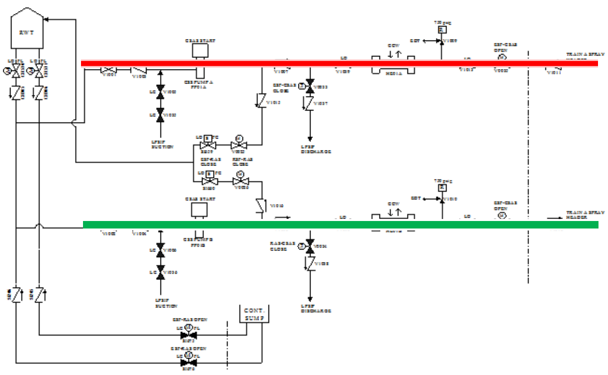

Figure 2 Containment Spray System for Typical Nuclear Power Plant

4. Conclusions

If a fire within the plant area results in spurious containment spray signal due to control circuit damage or concurrent spurious actuation of the containment spray pump and discharge valve, boric acid in the refueling water tank (RWT) would be discharged into the containment and the depletion of the boric acid used for reactivity control and primary inventory control during safe shutdown operation could occur for that reason. In this scenario, safe shutdown operation will be threatened by the loss of reactivity control and inventory control functions. This scenario is very likely because MSO occurred in only one train out of two trains of the system and be able to sufficiently lead to adverse impact to the safe shutdown function. However, because RWT is classified to equipment important to safety, the performance based methods such as operator manual action (OMA), fire modeling, or fire PSA can be applied to the resolution of this MSO noncompliance instead of deterministic compliance methods. When the operator manual action is applied to the resolution of this MSO scenario, then the feasibility and reliability of this operator manual action should be demonstrated by showing that the action is sufficiently accomplished within available time window. In addition to the time margin for this action, tools needed to this manual action, qualified personnel, local accessibility, relevant procedures, and sufficient indications should be also demonstrated.

Acknowledgement

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