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A Pilot Study on Applying Risk Informed Application Option 2 to Two Systems in UCN 3

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1. Introduction

To reduce the unnecessary burden of a regulation, NRC prepared three options for the risk informed regulatory framework known as Option 1, Option 2 and Option 3[1]. In Option 2, all safety related Structure, System and Components (SSCs) and non-safety related SSCs are evaluated from a safety point of view, and the low safety significant SSCs belonging to the safety related group are called 'Risk Informed Safety Class (RISC) - 3' SSCs. The 'RISC-3' SSCs can be exempted from the special treatment requirements such as a seismic and environmental requirement, of 10 CFR 50.

For Option 2, 10 CFR 50.69[2] was issued by US NRC, and NEI 00-04[3] was prepared by US industry as a categorization guideline for 10 CFR 50.69, and US NRC endorsed the NEI 00-04 methodology for Option 2 in Reg. Guide 1.201[4].

This paper describes the Option 2 method applied to the high pressure safety injection system (HPSI) and the essential service water system (ESW) of UCN 3.

2. Methods and Results

SSCs of HPSI and ESW of UCN 3 were categorized by the NEI Option 2 methodology [3] except for calculating component RAW (Risk Achievement Worth). The following is a summary of the applied method.

1. Identification of the system functions, and a coarse mapping of the components to the functions.
2. Categorization of the components. If modeled in PSA, Fussell-Vesely (FV) and RAW are used. If the FV of a component is larger than 0.005 or RAW is larger than 2, then the one is regarded as 'safety significant'. For the low safety significant components, sensitivity studies are performed, such as decreasing all human error basic events to their 5th percentile value, increasing all human error basic events to their 95th percentile value, etc.
3. Defense-in-Depth (DID) Assessment. If the component is safety-related and found to be of a low safety significance, it is appropriate to confirm that the DID is preserved.
4. If any component has high safety significance, then the associated system function is assigned high safety significance. Once a system function has been identified as a safety significant one, then all components that support this system function are assigned a safety significant categorization.

In Option 2, the number of SSCs to be categorized is too many to handle, so the FVs and RAWs of the components are practically derived in a convenient way with those of the basic events which have already been acquired as PSA (Probabilistic Safety Assessment) results instead of by reevaluating the fault tree/event tree of the PSA model. That is, the group FVs and RAWs for the components are derived from the FVs and RAWs of the basic events which consist of the group. Here, the basic events include a random failure, Common Cause Failure (CCF), test and maintenance, etc. which make the system unavailable. A method called the "Balancing Method"[5] which can practically and correctly derive the component RAW with the basic event FVs and RAWs even if CCFs exists as basic events was used in the HPSI and ESW's SSCs categorization.

The equipment quality class is classified as Q (Safety-related), T (Safety Impact), R (Reliability Critical), and S (Industrial Standard) class in UCN 3. In this study, it is assumed that the Q and T class items are safety related items.

In the categorization of the components, a component's contribution to fire PSA as well as a full power internal PSA is considered. However, the consideration of a fire PSA does not change the results derived from a full power internal PSA.

2.1 Evaluation of HPSI System

In Table 1, there are 307 items in the HPSI among which 136 items (Q=105, T=11, S=20) are safety significant ones, and 171 items (Q=148, T=13, S=10) are low safety significant ones. Thus, some special treatment requirements can be exempted for the 161 RISC-3 items and rather enhanced requirements should be applied to the 20 RISC-2 items.

The low safety significant equipment, in the HPSI system are SI-603, SI-321, FE-391, SI-523, SI-957, SI-522, SI-604, SI-331, FE-390, SI-533, SI-958, SI-532 valves which are used only for a "Simultaneous Hot and Cold Leg Injection Mode" when a Shutdown Cooling System (SCS) entry condition cannot be achieved within four hours following a LOCA (in particular, large and medium break LOCAs).

	Safety-related	Non-Safety-related	Total
Safety Significant	116	20	136
Low Safety Significant	161	10	171
Total	277	30	307

Table 1. HPSI System Components of UCN 3

2.2 Evaluation of the ESW System

As a result of the importance measure assessment, it turned out that 4 pumps and valves 067, 068, 1019, 1020 are safety significant. Therefore, all the components which fulfill the functions together with those components are also safety significant.

In Table 2, there were 285 items for the ESW system in the UCN 3 equipment list after neglecting several duplicated identification numbers issued by different department for the same equipment. Among them, 121 items (Q=86, T=31, S=4) are safety significant, and 164 items (Q=41, T=80, S=43) are low safety significant. Thus, if it is assumed that the Q and T items are safety related, then the RISC-3 items are 121. In Table 2, relaxed criteria can be applied to 121 items, and enhanced regulation requirements should be applied to 4 RISC-2 items.

	Safety-related	Non-Safety-related	Total
Safety Significant	117	4	121
Low Safety Significant	121	43	164
Total	238	47	285

Table 2. ESW System Components of UCN 3

3. Conclusion

More than half of the safety-related equipment could be relaxed from the special treatment requirements. Although Option 2 was applied to only two systems of UCN 3, the basic concept of Option 2 could be well understood so that Option 2 could be easily applied to all the systems of UCN 3.

Acknowledgement

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