**CALCULATION OF SEISMIC SEVERE CORE MELT
FREQUENCY USING INTERNAL EVENT MODELS FOR K
REACTOR (U)**

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A document prepared for:
Risk Management Quarterly
Brookhaven National Laboratory
at Upton, NY

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DEC 16 1993

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DOE Contract No. DE-AC09-89SR18035

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Date: 10-20-93

Summary

A new method of calculating the seismic contribution to the Severe Core Melt Frequency (SCMF) of operating the K Production Reactor at the Savannah River Site (SRS) has been developed. The methodology provides a direct link between the seismic analysis and the internal events PSA and facilitates the seismic analysis if a Level 1 internal events PSA exists for a facility. It improves the accuracy of the SCMF calculations and allows evaluation of the effects of seismic plant equipment and procedure modifications on the SCMF.

In the first step of the analysis, a seismic initiating event tree is constructed, linking the initiating event to the seismically-modified internal event and fault trees. The top events in this tree include the seismic initiating event and all other seismically-induced failures that can cause an accident. These failures correspond to the normal internal accidents that can be caused by a seismic event (e. g., a seismically-induced primary loss of coolant accident) as well as any other credible seismically-initiated accidents. Consideration of all possible combinations of accidents (e. g., seismic loss of offsite power and seismic loss of cooling water supply) taking place at the same time is also necessary. Support systems common to each accident sequence such as power and availability of cooling water are included as top events in the initiating event tree so that it is only necessary to model their seismic failure modes one time instead of each place that they are used. Quantification of the initiating event tree alone permits the calculation of the seismic SCMF with no credit for mitigating systems. If this value is acceptable, no additional seismic analysis work is required.

The mitigating trees are constructed by taking the internal event tree for an accident (e. g., loss of cooling water supply from the Savannah River to K Area) and adding to it additional top events that are required because of the seismic event. The K-Reactor seismic analysis indicated the likelihood of small primary coolant system leaks and secondary coolant system leaks after a seismic event due to flexing of flanged connections in the systems. Therefore, each mitigating tree had top events added to model the responses necessary to mitigate these leaks. Each internal event fault tree included as a top event is then modified by the addition of seismic failures so that the solution will include both the internal failures and the seismic failures.

In order to calculate the seismic SCMF, it is necessary to quantify the seismic initiating event tree and the mitigating trees using the site-specific seismic hazard curve. The hazard curve provides the frequency of having earthquakes of different peak ground acceleration (PGA) levels at the site being evaluated. Fragility values (seismic failure probability) must be calculated for each seismic failure at each peak ground acceleration (PGA) level for which the SCMF will be evaluated. The method used for the K-Reactor quantification involves the use of the CAFTA series of PSA codes [2] to calculate the cut sets for each sequence in the mitigating trees. CAFTA is also used to calculate the cut sets for each individual top event in the seismic initiating event tree. Linked Boolean expressions for each initiating event tree / mitigating tree sequence are constructed using the cut sets. Since in a seismic event the probability of the success paths may differ from the 1.0 that is normally assumed (e. g., a "success" of emergency power may have only a 0.7 probability) the Boolean expressions are written to include a probability of (1-failure probability) for each success event. The Boolean expressions, seismic component fragility data, and the seismic hazard curve are input to the Seismic Hazard Integration Package (SHIP) computer code written by Jack Benjamin and Associates for Westinghouse Savannah River Company [3], which

performs a numerical integration of the expressions over the entire hazard curve (0.02g to 1.7g) to calculate the SCMF value.

The results of the analysis described above show that the extra effort involved in using modified internal events results is worthwhile in terms of the added accuracy and usefulness of the seismic models. It also simplifies the seismic evaluation when a PSA already exists. The results can be used to study the effectiveness of performing seismic upgrades to the various components that the analysis shows to be important to the seismic SCMF. The results also show where additional procedural guidance would be useful to reduce the risk of core melt as a result of a seismic event.

References

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2. *CAFI/CAF386 Version 2.2c*, Science Applications International Corporation, (proprietary software) (May 22, 1992).
3. SHIP, Jack Benjamin and Associates, Mountain View, CA (April 1993).

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