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PRA APPROACH FOR DETERMINING
CRITICALITY SAFETY OPERATIONAL LIMITS

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SUMMARY

The Nuclear Safety Engineering Department (NSED) at the Rocky Flats Plant (RFP) in 1992 officially created within Criticality Analysis Engineering (CAE) a group of Probabilistic Risk Assessment (PRA) engineers. Previously, a single Criticality Engineer would generate a Criticality Safety Operating Limit (CSOL) based on the extensive analysis of configurations that could result in a criticality. Conceivable configurations that could not be proven impossible had to be addressed. Having to address and protect against all conceivable critical configurations resulted in the extensive use of Monte Carlo codes such as KENO. These analyses required many months of effort.

The CSOL process now uses a team approach to developing CSOLs. The analysis begins formally with a team meeting. The team members represent the CAE, PRA, and Human Factors Engineering (HFE) specialties in a synergistic process that focuses the CSOL process on areas most likely to be fruitful. The team works together to develop criticality scenarios that realistically account for the most likely failure chains. Operations personnel provide a perspective with respect to needs that must be satisfied for the CSOL to be useful. Input from PRA and HRA removes impossible scenarios from consideration by use of probabilistic analysis. Shortly after the initial team meeting, the team members participate in a walkdown of the operating facilities requesting the CSOL. Operations personnel participate in the walkdown and answer questions about the standard procedures and the existing protective hardware. With the insight gained from the team meetings and the walkdowns, team members have the information needed to expedite the process of CSOL development. This new CSOL process then results in a reduced expenditure of total man-hours through early and proper identification of desired barriers for criticality scenarios.

Including PRA and HRA in the safety analysis process is not entirely new to the NSED. These techniques have long been used for the generation of Safety Analysis Reports (SARs) and other safety documents. The new CSOL

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process, now extends these PRA and HRA tools and techniques to CSOL development as well.

A probabilistic interpretation of the Double Contingency Principle (DCP) has been previously developed in a IEEE paper presented by NSED Engineer, B.P. Hallbert, "The Evaluation of Human Reliability and Process System Analysis", 1992. CAE now uses DCP for the implementation of Department of Energy orders for CSOLs:

The top event is shown to have a single contingent frequency of less than $1E-6$ /year, and therefore is considered Not Credible, OR,

The top event is shown to be the result of two independent unlikely events. In the DCP model, the first event is the initiating event with a per year frequency. Given that this event occurs, then the second event, known as the enabler, must also occur during the mean time for recovery for the first event. The probability of occurrence for the enabler must be less than $1/100$. Standard fault tree methodology is used in the combination of frequencies and probabilities.

Using the PRA approach to criticality analysis, it is no longer necessary to show that some scenario, such as the formation of a critical sphere, is impossible. The criticality scenario must be shown either Not Credible or Double Contingent. This change in philosophy results in the saving of numerous man-hours that were previously spent proving and protecting against impossibilities. Showing that an event is Not Credible or Double Contingent is now the policy for determining if an acceptable level of risk has been documented.

This team process incorporating PRA and HRA methodology then culminates in a final meeting with Operations personnel. The resultant CSOLs are then accepted after a full review process and explanation of the basis for the analysis.

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