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APPLICATION OF PROBABILISTIC RISK ASSESSMENT TO REPROCESSING

by

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ABSTRACT

The Savannah River Laboratory uses probabilistic methods of risk assessment in safety analyses of reprocessing facilities at the Savannah River Plant. This method uses both the probability of an accident and its consequence to calculate the risks from radiological, chemical, and industrial hazards. The three principal steps in such an assesment are identification of accidents, calculation of frequencies, and consequence quantification. The tools used at SRL include several databanks, logic tree methods, and computer-assisted methods for calculating both frequencies and consequences.

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TEXT

The Savannah River Laboratory is applying probabilistic risk assessment to reprocessing, fuel fabrication, waste handling, and laboratory operations, as well as to reactors. This talk (Slide 1) is about our work in its application to reprocessing operations at the Savannah River Plant. The basic methods and philosophy are much the same for reprocessing and reactor operation, but the application must be somewhat different, just as these operations are different.

First, I would like to define the words probabilistic, risk, and assessment in some detail.

The word probabilistic indicates that a new consideration has been added to the older safety analysis methods. This new element is probability, or in some cases frequency. In our attempts to improve safety analysis, we have not discarded what was good in the older methods. Rather, we have built on it. (Slide 2) Probability was not an important part of these three types of old-style safety analysis. Each of them contributed to our state-of-the-art we use today. But each ignored probability, assumed the event occurs, and then focussed on consequences.

In the subjective analysis, an inspection of proposals for new equipment and process flowsheets or tours of existing facilities were made by knowledgeable experts to identify hazardous conditions. Where protection was inadequate, action was recommended.

This "fault-finding" approach was not very systematic and was heavily dependent on the experience of the inspector.

In a worst-case analysis, the consequences of the worst credible accident were analyzed and, if found acceptable, no action was taken. If unacceptable, engineered safety features or improved procedures and safety rules were installed until a consensus of acceptability was achieved.

The next type of analysis, the deterministic analysis, used subjective analysis to formally identify a list of hazards and potential accidents as completely as possible and, then, used worst-case analysis to identify the consequences of each accident. As before, engineered safety features, safety rules, and improved procedures were added where needed.

Note that none of these analyses considers the probability of an accident. Now, if we add probability to the deterministic analysis we have something very much like what is now called probabilistic risk assessment.

The goal is risk (Slide 3), which is defined as the product of frequency and consequence. For a complex facility with a variety of unit operations, the risk for the facility is the sum of the risks for each. Alternatively, the risk may be calculated for each type of potential accident and summed.

The units of risk depend on the kind of hazard under consideration (Slide 3). We naturally give radiological hazards first priority in our analyses, but not exclusively. We also analyze for chemical and industrial hazards using this same methodology. To accomplish all this requires many tools (Slide 4). The principal ones were mentioned in the previous talk on our databanks. They provide guidance in each phase of analysis: identification of hazards, calculation of frequencies, and consequence evaluation. Where events are not rare, data can be treated by our computer codes to provide the statistical data we need on a given accident. (Slide 5) A curve-fitting program gives us a choice of five standard distributions. We use the mean and median values for the one that best fits our data.

Where events are too rare for this statistical analysis, we use the fault-tree method and data for the more-frequent initiating events that lead to or cause the rare event.

For the consequences of the rare event, we must resort again to calculational methods. Modelling the consequences of rare events is too broad a subject to even begin today. We do use available models and event trees to quantify our consequences in terms of quantities released. Then, we use established computer codes to calculate the transport of released radioactive material, both gaseous and liquid, onsite as well as offsite.

Finally, our work is not done until a Safety Analysis Report is prepared and approved.

SLIDE 1

APPLICATION OF PROBABILISTIC RISK ASSESSMENT TO REPROCESSING OPERATIONS

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SLIDE 2

TYPES OF SAFETY ANALYSIS

- O SUBJECTIVE
- O WORST-CASE
- O DETERMINISTIC
- O PROBABILISTIC

SLIDE 3

HAZARD TYPE	UNITS OF RISK*
RADIOLOGICAL	CURIES RELEASED/YR, DOSE/YR
CHEMICAL	EXPOSURES (>AEL)/YR
INDUSTRIAL	ACCIDENTS/YR

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* RISK = (FREQUENCY) X (CONSEQUENCES)

SLIDE 4

TOOLS FOR RISK ASSESSMENT

COMPONENT	TOOLS
IDENTIFICATION OF HAZARDS	GENERIC INCIDENTS DATA BANK
ACCIDENT FREQUENCIES	FAULT TREE DATA BANK STATISTICAL ANALYSIS FAULT TREES, EVENT TREES
CONSEQUENCES	DATA BANKS CONSEQUENCE MODELS TRANSPORT CODES DOSE CODES

STATISTICAL ANALYSIS STEPS

1. FAULT TREE DATA BANK SORTING

2. INTERVAL CALCULATION (TIME BETWEEN EVENTS)

3. CURVE FITTING:

   NORMAL
   LOG-NORMAL
   LOG-UNIFORM
   EXPONENTIAL
   WEIBULL

4. OUTPUT:

   CHI-SQUARE
   MEAN TIME BETWEEN EVENTS
   MEDIAN TIME BETWEEN EVENTS
   STANDARD DEVIATION