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# PREPARATION OF SARs FOR NONREACTOR NUCLEAR FACILITIES AT THE SAVANNAH RIVER PLANT

by

William S. Durant

E. I. du Pont de Nemours & Co.
Savannah River Laboratory
Aiken, SC 29808

MASTER



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## DISCLAIMER

**Position and Area of Responsibility**

William S. Durant is a research Associate in the Actinide Technology Division of the Savannah River Laboratory. He is primarily responsible for the development of probabilistic risk assessment methodologies for the fuel reprocessing facilities at the Savannah River Plant.

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**Abstract**

Safety Analysis Reports for designated non-reactor nuclear facilities at the Savannah River Plant are prepared in accordance with the DOE Savannah River Manual Chapter 52X1. The accident analysis section is based on the Integrated Risk Assessment Plan, a methodology developed by the Savannah River Laboratory for reprocessing facilities. In general, designated facilities contain radioacitve, chemical, or other materials to the extent that a credible accident could have a significant detrimental effect on health and safety. The responsibility for specifying which facilities are designated rests with the manager, Savannah River Operations Office.

## Introduction

The Savannah River Manual Chapter 52X1 specifies the contents of an SAR in eight broad categories as shown in Slide 1. Each of these categories is further divided typically as shown in Slide 2, the facility and process design description. For the most part, the format is straightforward. However, Section 5 on accident analysis leaves the analyst with a great deal of freedom for innovative work. One is required to list accident initiators, describe the analytical techniques, calculate accident frequencies, calculate accident consequences, and combine the latter two to yield the risk. The manner in which this is done is not specified. The Savannah River Laboratory has developed an integrated risk assessment methodology that has been applied to systems in the nuclear fuel reprocessing facilities at the Savannah River Plant. The overall methodology is illustrated in Slide 3. Basically, the analysis is subdivided into individual modules that can be either utilized separately or integrated into an overall risk analysis. Computer codes and computer data banks are utilized extensively to minimize the manual effort. The flow of information begins with a definition of the system to be analyzed followed by:

- an evaluation of sources of fault information
- storage of this information in data banks
- design analysis and data treatment
- risk calculations
- selection of end product options.

Fuel reprocessing plants are best treated as unit operations. Such a treatment is a reasonable optimization of computer code capability, manpower, and calculational precision. Although each case must be considered individually, equipment or operations may generally be grouped under a single analysis if: 1) the physical form of the radioactivity and the matrix is the same, 2) the ratio of the nuclides of interest does not vary significantly, 3) the pathways for transport of radioactivity through protective barriers correspond, and 4) the stresses to which the equipment is subjected are similar.

**Sources of Data**

Sources of raw data for risk assessment include data from DOE reprocessing sites, environmental impact statements, safety analysis reports, license applications, theoretical and experimental studies, waste management alternative reports, journal articles, and risk assessments by industrial engineering firms on existing or proposed commercial reprocessing plants. Several types of information have been extracted from these reports, including actual incidents, potential incidents, consequences, and engineered safety features designed to prevent, detect, or mitigate such incidents.

**Data Storage**

These data have been stored in several data banks in a manner suitable for sorting and retrieval of the information for use with other modules of the assessment. The data banks include a generic incident data bank that contains known potential incidents that could occur in each of the unit operations associated with fuel reprocessing. Also included are causes of these incidents, consequences in general terms, and engineered safety features.

The fault-tree data bank contains actual deviations from normal operation, including the dates of occurrence. These incidents are coded by site location, facility, unit operation, and keyword so that they can be recalled by a wide variety of specifications compatible with qualitative fault tree construction. In addition, the incidents may be recalled and analyzed with a computer code called STATPAC that fits times between occurrence to five standard distributions. The code calculates the mean and median times between occurrences, the standard deviation, and the parameters required to determine error bounds by the SAMPLE computer code. A chi-square test is also run as an aid in determining the best distribution equation. The parameters thus calculated are stored in a failure rate library for automatic retrieval by the fault tree quantification codes.

The meteorological data banks contain one year of weather information on all areas of the United States. The Savannah River Plant has a similar bank with two years of information. Meteorological averages or probability distributions can be constructed from these banks.

The population data bank contains the 1970 census data. Population is enumerated by census districts for the total United States. These can be updated to reflect the present population or projected by regional population growth.

**Design Analysis and Data Treatment**

The design and systems analysis phase includes review and evaluation of the process, the physical location of the operation, and the specific items that could affect either the magnitude of release, the type of releases, or the frequency of a consequence. This is a key area for considering the effect of additional safety features. Information used is this module is derived largely from design documents and from the data banks previously discussed. The system is studied to determine that it is both functional and reliable. The effects of equipment location changes and process modifications are evaluated. Desirable design changes and engineered safety features can be incorporated into the basic design to serve as a model for further analysis.

**Risk Analysis**

The logic models normally involve the use of event trees and fault trees. Fault trees are generated based on information from five steps: experience with the unit operation being analyzed, experience with related unit operations, published studies of potential incidents, judgment of the technical analyst, and discussions with production personnel. Several combinations of fault tree quantification codes have been used successfully at Savannah River including PREP-KITT, MOCUS-SUPERPOCUS, and FTAP-IMPORTANCE. The SAMPLE code has been used to calulate distributions in both frequency and consequence data. Report quality copies of fault trees are generated by the TREDRA computer code.

Presently, onsite and offsite atmospheric transport and doses are calculated by a computer code. The code considers the internal dose from inhalation and the external dose from immersion in the cloud (cloud shine) and from exposure to surface deposition (ground shine). In addition, the effect of aqueous releases on offsite populations through the consumption of drinking water is determined by simple calculations.

In summary, the above describes the methodology for the preparation of SARs at the Savannah River Plant. These documents are required to be reviewed and updated as necessary on a five year cycle or if any significant changes are made to the process.

**FIGURE 1. SAR Format**

1. Summary Description
2. Site Evaluation
3. Facility and Process Design
4. Description of Operations
5. Accident Analysis
6. Safety Related Items
7. Quality Assurance
8. Glossary

**FIGURE 2. Facility and Process Design Description**

- Design Criteria
- Facility Description
  - Primary Facility Summary Description
  - Process Design Considerations
  - Instrumentation and Controls
  - Electrical Power Distribution
  - Auxiliary Systems and Support Facilities
- Engineered Safety Features
- Decommissioning Considerations

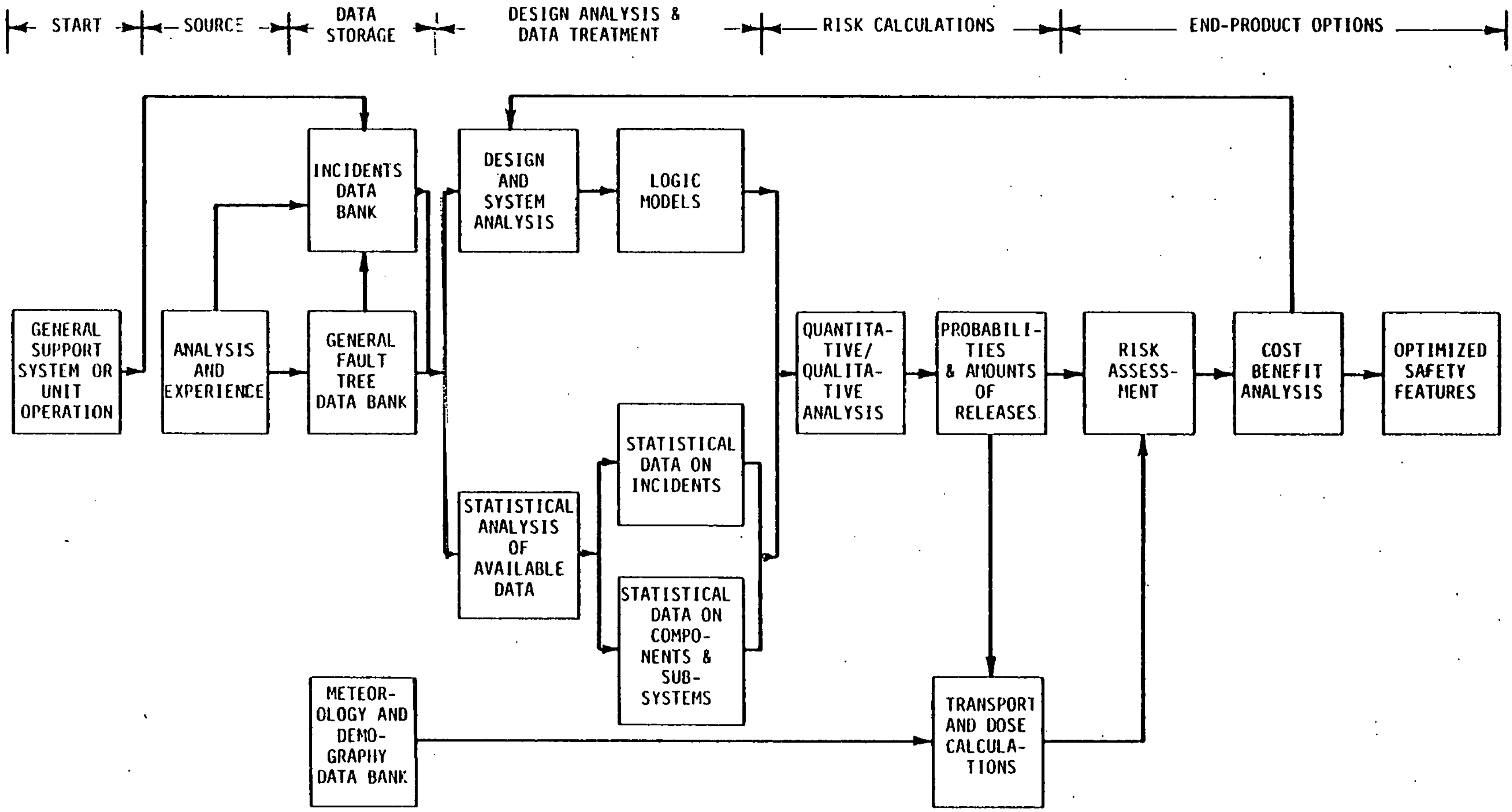


FIGURE 3. Integrated Risk Assessment Plan