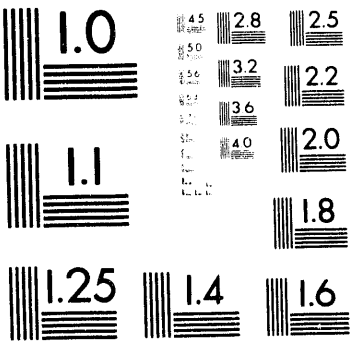
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SITE-WIDE SEISMIC RISK MODEL (U)

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SITE-WIDE SEISMIC RISK MODEL

FOR SAVANNAH RIVER SITE NUCLEAR FACILITIES

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Introduction

The 200,000 acre Savannah River Site (SRS) has nearly 30 nuclear facilities spread throughout the site. The safety of each facility has been established in facility-specific safety analysis reports (SARs). Each SAR contains an analysis of risk from seismic events to both on-site workers and the off-site population. Both radiological and chemical releases are considered, and air and water pathways are modeled. Risks to the general public are generally characterized by evaluating exposure to the maximally exposed individual located at the SRS boundary and to the off-site population located within 50 miles.

Although the SARs are appropriate methods for studying individual facility risks, there is a class of accident initiators that can simultaneously affect several or all of the facilities. Examples include seismic events, strong winds or tornadoes, floods, and loss of off-site electrical power. Overall risk to the off-site population from such initiators is not covered by the individual SARs. In such cases multiple facility radionuclide or chemical releases could occur, and off-site exposure would be greater than that indicated in a single facility SAR.

As a step towards an overall site-wide risk model that adequately addresses multiple facility releases, a site-wide seismic model for determining off-site risk has been developed for nuclear facilities at the SRS. Risk from seismic events up to the design basis earthquake (DBE) of 0.2 g (frequency of 2.0E-4/yr) is covered by the model. Present plans include expanding the scope of the model to include other types of initiators that can simultaneously affect multiple facilities.

Methodology

Development of the SRS seismic risk model involved four steps:

1. Identification of all nuclear facilities at the SRS

2. Review of seismic accident analyses (radionuclide and chemical releases and air and water pathways) in facility SARs

3. Updating of air dispersion and dose calculations for seismic accidents to obtain up-to-date and consistent results (1992 off-site population and ICRP-30 dose model)

4. Integration of individual facility results to obtain a site-wide risk model.

Nuclear facilities at the SRS were identified by a review of existing SARs and a review by cognizant safety personnel. The SRS has 29 different facilities historically classified as nuclear. This list does not include storage and waste facilities with very small amounts of radionuclides and whose classification is presently

undecided. Such facilities would not significantly contribute to the off-site risk.

Once the nuclear facilities and SARs were identified, the seismic accident analyses were reviewed. Several cases were encountered in the SARs:

- Single seismic accident analysis for the DBE (for facilities that do not release significant quantities of radionuclides or chemicals for earthquakes weaker than the DBE)
- Multiple seismic accident analyses for the DBE to cover different sources of radionuclides or chemicals or different accident phenomena
- Multiple seismic accident analyses covering a spectrum of earthquakes up to the DBE (for facilities that can release significant quantities of radionuclides or chemicals for earthquakes weaker than the DBE)
- Multiple seismic accident analyses covering a spectrum of earthquakes up to and beyond the DBE (for some of the newer SARs).

Of the 29 nuclear facilities, 12 were chosen for inclusion in the seismic risk model based on their seismic-initiated off-site risk (as indicated in their SARs). These 12 facilities contribute over 99% of the site-wide seismic risk to the off-site population. All seismic accidents (up to the DBE) for these facilities were then included in the model. The 12 facilities contributed a total of 15 seismic accidents to the model.

Because the atmospheric dispersion calculations for the 12 facilities had been performed over a period of 10 years (1983 to 1993), inconsistencies existed with regard to the off-site population assumed and to the dose model used. All of these dispersion calculations were rerun using the most up-to-date SRS atmospheric dispersion code, AXAIR89Q.[1] Therefore, all analyses were standardized using the 1992 off-site population, the ICRP-30 dose model, and SRS meteorological conditions based on the period 1982 through 1986.

The final step in developing a site-wide seismic risk model involved integrating the individual facility seismic risks. The two main measures of off-site population radiological risk used at the SRS are the following:

- Risk to the maximally exposed individual located at the SRS boundary (dose in rem, multiplied by the accident frequency)
- Risk to the off-site population located within 50 miles of the site (dose in person-rem, multiplied by the accident frequency).

The location of the maximally exposed individual at the site boundary varies with facility location within the SRS, as shown in Figure 1. Because of this and because a single site boundary location is needed for the site-wide model, the individual facility doses and risks to the site boundary individual are not additive. At a given instance in time, the wind direction across the site is relatively uniform. This implies that release plumes from certain facilities may not overlap at the site boundary. Therefore, the location of the maximally exposed individual at the site boundary for the dominant risk facility was chosen as the location for the site-wide model. Then releases only from facilities whose release plumes overlap this location were included for the site-wide calculation of risk to the individual located at the site boundary.

In contrast, all facility results can be added to determine the site-wide risk to the off-site population located within 50 miles.

Also desired were the exposures for the maximally exposed individual at the SRS boundary and the off-site population. To obtain these doses, only the DBE accidents from each facility were used. (To include other seismic accidents for less than the DBE would result in overestimation of the integrated dose. This problem of overestimation does not occur when risk measures are calculated, because the frequencies of the accidents are factored into the calculation.) Otherwise, the dose results were combined in a manner similar to what was done

for the risk results.

Results

The resulting seismic risk model for the SRS appropriately integrates individual facility radiological risks to obtain the site-wide risk to the maximally exposed individual at the site boundary and to the off-site population. Also, the doses for the maximally exposed individual and the off-site population are apporpriately integrated. Both radiological and chemical releases and air and water pathways were initially considered in the development of the model. However, only air dispersion of radionuclides turned out to be significant with respect to risk to the off-site population.

Final site-wide risk and dose results were approximately twice the results from the most dominant SRS facility. However, the site-wide results could have been much higher if facility locations at the SRS had been different or if none of the facilitieshad been dominant with respect to risk.

References

1. J. C. Huang and C. R. Lux, AXAIR-89: An Improved Version of the AXAIR Code, Westinghouse Savannah River Company, WSRC-RP-89-1197, 1989.

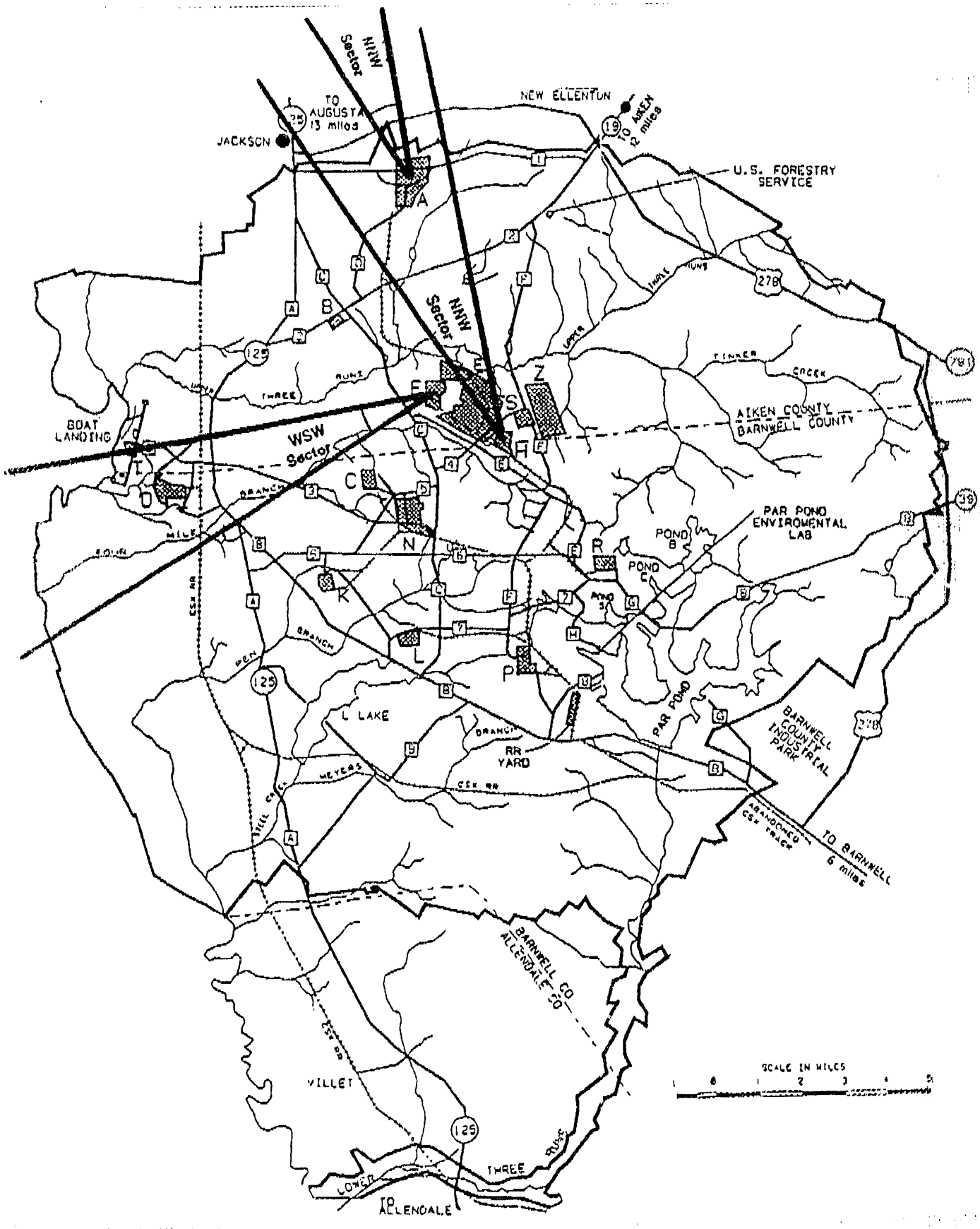

Figure 1. Savannah River Site boundary.

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