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John A. Harris, Director, Office of Information Services

SYMPOSIUM ON ENVIRONMENTAL BEHAVIOR OF RADIONUCLIDES RELEASED IN THE NUCLEAR INDUSTRY

Enclosed are abstracts of four papers on 04-program activity for presentation at the IAEA Symposium on Environmental Behavior of Radionuclides Released in the Nuclear Industry to be held at Aix-en-Provence, France, May 14-18, 1973.

These four papers are all concerned with the joint Atomic Energy Commission - Tennessee Valley Authority study of the potential radiological implications of an expanding nuclear power industry in the Tennessee Valley region of the U.S. and should be treated as an integral set of papers. Each paper, with the exception of the one entitled "A Study of the Potential Radiological Impact of an Expanding Nuclear Power Industry on the Tennessee Valley Region," which gives an overview of the study, presents the procedures and data utilized in a major segment of the study. Collectively, the papers will provide the status in the U.S. of the following topics:

(1) The nature of potential releases of radionuclides from the normal operation of nuclear power and fuel reprocessing plants.

(2) The application of mathematical models to the environmental transport and concentration processes of radionuclides.

(3) The estimation of dose to man from internal and external modes of exposure from radionuclides released from nuclear power and fuel reprocessing plants.

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FOLDER 040191011 - Rad. Impact of an Expand. Nuclear Power

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If we can be of further assistance, please feel free to call on us.

Milton Shaw, Director
Division of Reactor Development
and Technology

Enclosures:
1. Methods of Estimating Dose to Man from Regional Growth of Nuclear Power
2. Potential Nuclear Power and Reprocessing Plant Siting and Radionuclide Releases Due to Normal Operation in the Tennessee Valley Region
3. Modeling the Regional Transport of Radionuclides in a Major U.S. River Basin
4. A Study of the Potential Radiological Impact of an Expanding Nuclear Power Industry on the Tennessee Valley Region

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METHODS OF ESTIMATING DOSE TO MAN FROM REGIONAL GROWTH OF NUCLEAR POWER*

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ABSTRACT

In cooperation with the United States Atomic Energy Commission (USAEC), the Oak Ridge National Laboratory (ORNL), the Tennessee Valley Authority (TVA), the Atmospheric Turbulence and Diffusion Laboratory-National Oceanic and Atmospheric Administration (ATDL-NOAA), and the Hanford Engineering Development Laboratory (HEDL) have undertaken a joint study of the potential radiological impact of an expanding nuclear power economy on the Tennessee Valley Region (TVR).

The TVR study involves an appraisal of the generation, management, and control of radioactive effluents from nuclear facilities in the region through the year 2000. It considers nuclear power requirements to year 2000 and sites for nuclear facilities, radionuclides that may be released and their transport in air and water and concentration in terrestrial and aquatic systems, and estimation and interpretation of potential dose to man.

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This is the second such regional study initiated by the USAEC in the continental United States; the first considered the region defined as the Upper Mississippi River Basin (UMRB). A computer model known as HERMES (Hanford Engineering Regional Model for Environmental Studies) was developed by HEDL and applied in the UMRB study. The model permits estimates, on a regional basis, of the potential radiation dose that may be received by individuals and population groups as a result of radioactive materials estimated to be released from reactors and fuel reprocessing plants.

Modifications in HERMES are discussed within the context of the uniqueness of the TVR and additions or improvements based on the initial application of HERMES. This paper, one of four companion reports, includes information on the data requirements and the components of HERMES concerned with radionuclide concentrations in food pathways and the estimation of dose to man from internal and external modes of exposure.

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POTENTIAL NUCLEAR POWER AND REPROCESSING PLANT SITING AND RADIONUCLIDE RELEASES DUE TO NORMAL OPERATION IN THE TENNESSEE VALLEY REGION

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The Tennessee Valley Authority is cooperating with the U. S. Atomic Energy Commission in an interagency study of the potential radiological impact of nuclear facilities on the Tennessee Valley region through the Year 2000. This study is one in a series of regional investigations as a part of the AEC's Year 2000 study to assess the nationwide impact of nuclear power facilities expected to be in operation by the end of this century. It makes use of the HERMES mathematical model developed at the Hanford Engineering Development Laboratory. Oak Ridge National Laboratory and the Atmospheric Turbulence and Diffusion Laboratory at Oak Ridge, Tennessee, are also participating in the study. The joint AEC/TVA study was undertaken because of the unique hydrologic and topographic characteristics of the Tennessee Valley region and the anticipated large-scale use by TVA of large nuclear power stations to help meet much of the region's continuing need for electricity.

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The study involves an appraisal of the generation, management, and control of radioactive effluents from nuclear power plants and fuel reprocessing plants, transfer and cycling of radionuclides through air and water, and concentration in terrestrial and aquatic systems and calculations of potential radiation dose equivalents and dose commitments to man. Data on long-range power projections by sites, load distribution among different plants, and generating unit availability are used in the model along with streamflow and runoff data, sediment adsorption characteristics, and existing and projected uses of the TVA reservoir system for irrigation and recreation. Information on food production and eating habits of the people in the region and expected changes in population distribution are also used in estimating population dose.

This study is based strongly on the use of data and information from TVA's ongoing programs in regional resource development, including large-scale generation of electric power, management of a large river-reservoir system, and comprehensive environmental assessment and management activities related to nuclear power facilities. It provides a state of the art assessment of the environmental consequences expected from the generation, handling, and treatment of radioactive waste effluents from several large nuclear power plants and fuel reprocessing plants.

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ABSTRACT

Modeling the Regional Transport of Radionuclides in a Major United States River Basin

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A comprehensive study of the radiological implications of large-scale use of nuclear power generation, addressed to the Tennessee-Cumberland river basins in the Year 2000, is being undertaken. In the course of this study, computer modeling techniques have been developed to evaluate the movement of radionuclides, by water and air transport, from points of release at a large number of plant sites, and to calculate patterns of radionuclide concentration throughout the region of study.

Air transport calculations utilize a modification of the bivariate normal equation, with the vertical parameter σ_z characterized as a function of distance from the source, stability, and mixing layer depth. Local variations in air flow caused by major terrain features are modeled. Depletion of the airborne radionuclides by wet and dry precipitation processes is accounted for, and the concentrations of deposited radionuclides are calculated. The model sums contributions from all sources to provide resultant patterns of concentration of airborne and deposited radionuclides, including contributions from radionuclides deposited in prior years.

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The water transport model calculates stream concentrations of radionuclides in solution and absorbed on sediments. Effects of flow stratification and sediment trapping in reservoirs are considered. The solution of air-deposited radionuclides and their subsequent transport in ground and surface waters are modeled. Calculational routines are provided for simulating radionuclide transport in each stream in the basin and for calculating the resultant concentrations in solution and associated with suspended and deposited sediments.

Together, the air and water transport models are designed to calculate regional patterns of radionuclide concentrations in the environment that result from the operation of nuclear facilities in a region. These concentration patterns can then be applied to the evaluation of radiological dose to man.

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A Study of the Potential Radiological Impact of an Expanding Nuclear Power Industry on the Tennessee Valley Region

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The U.S. Atomic Energy Commission initiated a study in January 1970 to develop a computer model (HERMES) and the necessary data to permit estimates through the year 2000 of the radiation potentially received by individuals and population groups in large regions as a result of various estimated radioactive release rates from reactors and fuel reprocessing plants. The initial phase of the study concerned development of the computer model and data for the analysis of the region comprising the Upper Mississippi River Basin (UMRB) of the United States. The results of the UMRB study are reported in WASH-1209, "The Potential Implications of the Nuclear Facilities in the Upper Mississippi River Basin Region in the U.S. in the Year 2000." This paper concerns the second phase of the study, an interagency study by the U.S. Atomic Energy Commission and the Tennessee Valley Authority of the potential radiological impact of an expanding nuclear power industry in the Tennessee Valley Region (TVR) through the year 2000. The Oak Ridge National Laboratory, the Hanford Engineering Development Laboratories and the Atomispheric Turbulance and Diffusion Laboratory at Oak Ridge, Tennessee are also participating in the study.

The TVR region is subdivided into about 140 centers of populations and the dose is calculated for the average individual in each center for each of four age groups (baby, child, teenager and adult). Contributions

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to dose by isotope and pathway for each of seven body components (total body, liver, lungs, G.I. tract, thyroid, bone and skin) are determined for each of the age groups. Sensitivity analysis are also done to evaluate the effects of uncertainties in the parameters believed to be most significant in their effects on dose.

The procedures, scope and HERMES model modifications established for the TVR study were guided by the results of the study of the UMRB. Those results of the UMRB that had a major effect on the planning of the TVR study are discussed. An overview of the TVR study is also provided. Details on site selection, radwaste treatment systems, radionuclide transport and dose modeling for the TVR study are given in following papers.

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