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THE AEC PROGRAM OF ATMOSPHERIC RADIOACTIVITY
AND FALLOUT RESEARCH

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Alfred W. Klement, Jr. and Joshua Z. Holland
Fallout Studies Branch
Division of Biology and Medicine
U. S. Atomic Energy Commission
Washington 25, D. C.

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The Atomic Energy Commission's program of atmospheric radioactivity and fallout research is the responsibility of the Division of Biology and Medicine. This program is concerned with the fate of radioactivity injected into the atmosphere and its effects on man (1, 2). As implied in the term "fallout", the program deals with a wide range of nuclear energy activities, including both military and peaceful applications.

The main purpose of the research program is to provide an increasingly complete and sound scientific basis for the prediction of radiation doses to man which may result from the introduction of radioactive material into the atmosphere. In this regard working techniques and computation models are developed for making such predictions. Also, sampling and analysis techniques are developed for experimentally testing the models. Although the program is not currently designed specifically to provide surveillance of environmental radioactivity, the data collected for research purposes are often useful to surveillance programs of the

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Department of Health, Education, and Welfare, and operational and safety activities of the Atomic Energy Commission. On the other hand, these surveillance programs as well as research programs of other organizations and government agencies provide information useful to the fallout research program of the AEC. Also, while only a part of the total research program of the Division of Biology and Medicine is specifically directed towards the problems of atmospheric radioactivity and fallout, a great deal of the overall program provides information applicable to fallout problems as well as other radiation problems (3). Close liaison and coordination is maintained within the AEC and with the departments of Defense and Health, Education, and Welfare because of the areas of mutual interest. In fact, in many ways we are dependent on the specialized resources of these agencies, the Weather Bureau and the Department of Agriculture for assistance in our program.

Historically the AEC atmospheric radioactivity and fallout research program has dealt with two fairly distinct sets of problems. These are the world-wide transport and distribution phenomena associated with weapons tests and the low-altitude local problems arising in industrial and laboratory operations. The program administered by the AEC Headquarters staff is conducted through research contracts with universities and industrial organizations, interagency agreements with other government agencies and AEC facilities. For administrative purposes it is convenient to divide the program into four subject matter categories

although these are not distinct in many cases. These are listed below. A list of organizations participating in the current program in each category is shown in the appendix to the paper.

(1) Atmospheric Chemistry, including acquisition of data on concentrations of specific nuclides in the atmosphere, precipitation and deposited dust, development of collecting devices and studies of aerosol chemistry and physics.

(2) Atmospheric Dynamics, which is essentially meteorology, including micrometeorology connected with local problems and global meteorology connected with weapons tests. Studies of scavenging and deposition processes and the development of transport and deposition models are included as well.

(3) Fallout Formation and Source Effects, which includes studies of chemical and physical processes involved before "cloud stabilization", partitioning of debris among local, tropospheric and stratospheric fallout as a function of burst conditions, chemical fractionation effects and total radiation intensity and rates of decay of nuclear debris.

(4) Radioactivity in Soil, Food and Man, including measurements of radionuclide content of soils, food and man, investigation of parameters in food production and distribution which influence dietary contamination, development of methods for estimating human intake and body burden and development of efficient survey and analytical techniques for assessing radioactivity in soil, food and man.

Current Problem Areas

The characteristics of sources of atmospheric contamination generally affect the fate of radioactive debris. The potential sources of atmospheric contamination of primary interest include the detonation of nuclear devices, releases of radioactivity into the atmosphere from experimental and operational nuclear power sources for rockets or guided missiles, large scale accidents involving nuclear processes, certain reactor operations and experiments and related activities. In order to study the effects of specific sources it is necessary to have knowledge of what radionuclides are present and are produced and the conditions under which the nuclides are released into the atmosphere. In the experimental testing of the various nuclear devices by the United States, conditions of release are generally well known and the total production of the nuclides involved may be ascertained or predicted to a relatively high degree of accuracy. The distinction among various particle sizes, and solubility in water or body fluids are still open to considerable study. In accidental situations, in nuclear warfare, and in operational situations all these factors may be unknown to a large extent and must be estimated from past experience and diagnostic measurements.

One of the major efforts of the fallout program is the study of atmospheric, terrestrial and aquatic influences on the distribution of nuclear debris. It involves studies of the atmospheric and surface phenomena pertinent to fallout distribution, studies of actual atmospheric

and surface distribution of radioactive material from current and past experiments and operations, and the relationships between the two. The objective here is to arrive experimentally or empirically at a basis for estimating the spatial distribution as a function of time of a given amount of radioactive material released under given conditions.

Studies of atmospheric phenomena include tracer experiments in dispersion rates over a few miles and on a world-wide scale, the behavior of aerosols and mechanisms by which they are washed out of the atmosphere. Studies of surface phenomena include the development of information concerning the effects of terrain slope and drainage, soil type, vegetation type and density on retention and redistribution of fallout. Distribution studies include the collection and analysis of samples of air (from the surface to the stratosphere), water (sea and fresh), precipitation and soil, identification of contributions from different sources by means of radiochemical analysis, and evaluation of the results in terms of the relation of overall distribution of radioactivity, as a function of time to the specific locations and amounts of past releases of radioactive materials to the atmosphere.

The significance of fallout material as an external radiation source is an area of study of considerable interest. This area and those mentioned below are only partly included in the specific research programs labelled as fallout studies and partly under other programs of the Division of Biology and Medicine. This part of the program is concerned with measuring or estimating the dose delivered by debris in the

atmosphere and on the ground. From actual operations where relatively accurate measurements can be made and exposed populations are known, estimates of dose may be made readily. Generally, this is the case in the immediate vicinity of the operation. To obtain estimates for larger areas and populations, estimates must be made on the basis of empirical or experimental findings from past events or models usually substantiated by few specific measurements. Of course, where predictions are to be made for future events, good models are essential. Estimates of averages and statistical distributions of external doses for large populations distributed over large areas provide the basis for estimating the effects on man for a particular event or series of events.

Of particular importance to the overall program is the distribution of radioactivity from atmospheric contamination in man's food. This problem is one of assessing the amounts of particular radionuclides which are taken into the body. An essential step is to study the distribution of radioactive materials in plants and animals which are involved in man's diet. Studies include uptake and "metabolism" of radionuclides from air, water and soil by plants and animals, uptake by animals from vegetation and uptake from all sources by man. Most of the work on biological cycling and metabolism of radionuclides is conducted under programs other than the Fallout Studies Program.

Research on the effect on man of atmospheric contamination is not carried under the Fallout Studies Program as such, but under other

programs of the Division of Biology and Medicine. These studies are designed to increase our basic knowledge of radiation effects regardless of the source. Results of these studies are applicable to problems of atmospheric contamination and many were designed because of their special application to atmospheric contamination problems. These studies involve the biological effects of radiation from sources inside and outside biological systems, including man. Research in this area includes studies of overall effects, effects on populations, including genetic effects, effects on specific organs and tissues and their functions. Ecological studies as well as specific studies of animals and plants are important in assessing the indirect effects of radiation on man through effects on his environment.

In addition to assisting the AEC in planning and conducting its operations, information obtained through the atmospheric radioactivity and fallout research program constitutes an essential input to the reviews prepared by other organizations concerned with the fallout problem. Examples include the Congressional hearings on fallout such as those held last week (June 3-6, 1963), the Federal Radiation Council reports on fallout of 1962 and 1963, and the reports of the United Nations Scientific Committee on the Effects of Atomic Radiation of 1958 and 1962. The results of the AEC atmospheric radioactivity and fallout research program are reported by investigators in scientific journals, AEC reports, reports of conferences and in the reviews mentioned above.

Suitable data are reported in Radiological Health Data issued monthly by the Public Health Service, and in the quarterly reports of the AEC Health and Safety Laboratory.

During the past year or so the need was seen for a central research program on early fallout short-lived environmental radiocontaminants. To fill this need an interdisciplinary long-range program has been initiated at the University of California Lawrence Radiation Laboratory at Livermore. This group will plan and conduct laboratory and field studies of environmental contamination due to the release of radioactivity from nuclear detonations conducted for peaceful or military purposes. The program will include studies of fallout from its formation to its distribution and biological effects in coordination and cooperation with other groups working in this field. It will emphasize the experimental study of early fallout and the effects of device design and conditions of detonation on the resulting fallout. The addition of this centralized program to the overall fallout research program will assist greatly in the understanding of fallout problems.

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APPENDIX

List of Current Participants in the AEC Radioactivity and Fallout Research Program

Atmospheric Chemistry

Aerojet-General Corporation
Australia, Department of Supply
Del Electronics Corporation
General Mills, Inc.
International Atomic Energy Agency
The Johns Hopkins University
New York University
Nuclear Science and Engineering Corporation
Research Triangle Institute
Sandia Corporation
Texas Instruments Incorporated
U. S. Air Force Air Weather Service
U. S. Air Force Cambridge Research Laboratories
U. S. Department of Defense
U. S. Department of Interior, Geological Survey
U. S. Naval Research Laboratory
U. S. Navy, Office of Naval Research
University of Arkansas
University of California at Los Angeles (Sekara)
University of Minnesota
University of Washington (Fairhall)

Atmospheric Dynamics

Argonne National Laboratory
Brookhaven National Laboratory
Hanford Laboratories
Hazleton-Nuclear Science Corporation
Illinois State Water Survey
International Atomic Energy Agency
Isotopes, Inc.
Massachusetts Institute of Technology
Meteorology Research, Inc.
U. S. Weather Bureau
U. S. Weather Bureau Research Station, Oak Ridge
University of Michigan
University of Oklahoma
University of Stockholm
University of Washington (Badgley)

Fallout Formation and Source Effects

Isotopes, Inc.
Tracerlab, Laboratory for Electronics, Inc.
U. S. Naval Radiological Defense Laboratory

Radioactivity in Soil, Food and Man

Argentine Comision Nacional de Energia Atomica
Argonne National Laboratory
Colorado State University
Consumers Union
Cornell University
Health and Safety Laboratory, U. S. AEC
National Bureau of Standards
Pontifica Universidade Catolica do Rio de Janeiro
U. S. Department of Agriculture
University of California at Los Angeles
University of California Lawrence Radiation Laboratory, Livermore