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Report: Status of Project Gabriel

Prepared by: Division of Biology and Medicine

Reference: Request dated October 22, 1953 from Honorable W. Sterling Cole, Chairman, Joint Committee on Atomic Energy, to Mr. Strauss, Chairman, U. S. Atomic Energy Commission.

## OBJECTIVE OF PROJECT GABRIEL

1. The objective of Project GABRIEL is the study of the probable effects, with particular reference to the inhabitants of affected regions, of the fall-out of radioactive materials from the use of nuclear weapons in warfare. Depending upon the conditions under which such weapons are used, the major interest may lie in the short range contamination from the use of a single weapon or in the number of weapons required to produce levels of contamination hazardous to the population of a major area.

2. The terms "short range" and "long range" as used in this discussion refer to time, although in general short range hazards will occur at relatively small distances from points of detonation. A large fraction of the dust (or water) swept up by the detonation of a nuclear weapon characteristically falls out in a limited area at some distance downwind from the point of detonation. The distance, size, and average level of radioactivity of this area will depend upon the altitude of detonation, characteristics of the weapon, and meteorological conditions. The short range hazard from a single event of this nature is due to the high levels of radiation from the fall-out during the first several hours or days after deposition, and may occur at distances of several scores of miles from the point of detonation. Long range problems are associated with the possibility of occurrence, over periods of months or years, of hazardous quantities of long-lived radioactive materials in the general food supply. Such a problem might result, on a local scale, from the intensive use of surface weapons over a few thousand square miles of area. However, the long range problem which has received the most consideration is that of eval-

uating the hazard from the use of large numbers of weapons under conditions such that the radioactive debris would be spread generally over a large fraction of a continent or, perhaps, over a large fraction of the earth's surface.

## STATUS OF THE PROJECT

3. The program involves the following phases:

a. Probable distributions of fall-out from a single event or from a small number of closely related events under various conditions;

b. Long range behavior of fall-out from multiple events; and

c. Evaluation of health hazards resulting from radioactive fall-out under the range of conditions which may be anticipated from actual warfare.

4. Several programs currently supported by the Division of Biology and Medicine were initiated specifically to supply information on the distribution and probable effects of radioactive fall-out from nuclear detonations. These include:

a. Studies of environmental effects of continental tests by the Atomic Energy Project at the University of California at Los Angeles, started at the Trinity test site in 1947 and extended to include the Nevada Proving Grounds;

b. Monitoring of the radioactivity of fall-out from weapons tests at approximately 100 stations in the United States and 70 stations outside the United States;

c. A theoretical study by Rand Corporation of the probable physical behavior of fall-out under conditions of interest; and

d. Studies of the occurrence in soils, vegetation, dairy products, animals and humans of strontium 90 and other fission products from nuclear weapons tests. Principal participants are identified in Paragraph 9.

5. The Atomic Energy Project of the University of California at Los Angeles has, in connection with the several series of tests at the Nevada Proving Grounds, studied the occurrence of radioactive materials in soils, plants and small animals taken within a radius of one or two hundred miles of the test site. These studies are supplemented by laboratory investigations of the uptake by plants of radioactive materials from soils containing fall-out from the test site, of the inhalation by small animals of radioactive dusts from the test site, and of related subjects.

6. Rand Corporation was given a contract in 1952 to make a theoretical study of those aspects of GABRIEL which, on the basis of available information, are amenable to such study. Their principal effort has been aimed at predicting probable fall-out from a single detonation under various conditions of use. A complete report on this phase of their studies is expected about January 1954.

7. Rand's primary contribution to the long range aspects of GABRIEL has been related to the organization of a conference in July 1953 to provide a critical review of the entire project by qualified personnel in related fields, and to the writing of a report on the conference. The final version of this report is complete.

8. At the 1953 Rand Conference, the code name SUNSHINE was adopted to identify that portion of Project GABRIEL dealing with direct sampling of the occurrence of strontium 90 as the result of weapons tests.

9. Of the radioisotopes resulting from the detonation of nuclear weapons, strontium 90 appears to be critical in the determination of hazardous long range effects. An exploratory sampling of the occurrence of strontium 90 in humans, animals, milk, vegetation and soils is in progress. Through the cooperation of the Bureau of Plant Industry, U. S. Department of Agriculture, samples of soil, vegetation, milk and animals from selected areas of the United States and samples of soil and vegetation from several foreign countries are being obtained. Human samples are being obtained through individual arrangements with hospitals and practicing physicians.

10. Assays of the materials sampled for strontium 90 are being made by W. F. Libby of the University of Chicago, by J. L. Kulp of Columbia University, and by the New York Operations Office of the U. S. Atomic Energy Commission. Studies of other characteristics of the samples bearing on the soil-plant-animal relationships involved are being made by the New York Operations Office, the Department of Agriculture, and others. It is expected that these studies will contribute to GABRIEL in the following ways:

a. Actual samples of the present human content of strontium 90 from some 40 detonations of nuclear devices under partially known conditions will add to the confidence with which one can estimate orders of magnitude of human uptake from other devices detonated under similar conditions. In general it will be difficult or impossible to evaluate the relative contributions of individual detonations.

b. Correlation with fall-out data and with the results of controlled experimental studies will permit better estimates of quantities of material which may be hazardous under the various conditions which may be anticipated in nuclear warfare.

The extent to which actual sampling of strontium 90 is desirable can be determined only on the basis of results from the exploratory program now in progress.

11. Although a reliable estimate of the present distribution of strontium 90 will represent a substantial contribution to GABRIEL, additional information is needed to permit reliable estimates of changes in availability for human uptake as a function of time and of biological effects as a function of dose and of dose rate. Studies of radiotoxicity have continually constituted an important phase of the research program of the Division of Biology and Medicine, but at present, aspects of particular interest to GABRIEL are being augmented and emphasized.

12. The first studies of the long range aspects of Project Gabriel were undertaken in 1949 for the Atomic Energy Commission by Dr. Nicholas Smith, a theoretical physicist then at the

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Oak Ridge National Laboratory. This revised estimate (November, 1951) stated that the number of nominal atomic bombs required to reach lethal levels of residual radioactivity on 10% of the earth's surface "is in the order of $10^5$ under expected circumstances. This estimate may be 100 times too low or 10 times too high." Limitations in our knowledge of the physical and biological properties of the radioactive products of a nuclear weapon, together with inherent uncertainties as to the conditions which might be involved in the use of such a weapon, impose a high degree of uncertainty on estimates of this nature. While continuing studies are increasing our knowledge of the behavior and effects of the radioactive materials involved, the range of known possibilities of design and use of nuclear weapons is continuing to broaden, adding to the unavoidable uncertainties inherent in predicting the results of their extensive use. The present stage of studies does not justify new numerical estimates of the possible long range effects of the use of large numbers of weapons. However, the trend of results indicates that to produce serious hazards over a large fraction of the earth's surface, a number larger than that estimated by Dr. Smith would be required.

13. In the event that GABRIEL develops a substantial basis for apprehension concerning the long range effects of strontium 90 in the environment as a result of nuclear warfare, it may become desirable to initiate further projects to study means of minimizing the hazards from such occurrence -- as for example, reallocating affected areas to the production of foodstuffs less inclined to utilize strontium (e.g., seed crops rather than dairy products), or development of methods to minimize uptake of strontium by plants as by liming.

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