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SUMMARY OF

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United States Atomic Energy Commission
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CURRENT RESEARCH FINDINGS ON RADIOACTIVE FALLOUT

The material summarized here is to be given as a speech at the dedication of the new building of the American Association for the Advancement of Science. The subject is radioactive fallout.1/ The remarks are an extension of previous discussions. Account is taken of the new information which is constantly flowing in. The theory of the processes occurring during fallout is fuller than that of previous discussions.

If one excepts the immediate vicinity and immediate time of the explosion, the principal hazard is due to the ingestion of radioactive fallout. It is obviously a long time hazard. Of the many radioactive elements present in the debris from a nuclear explosion, strontium-90 (Sr^{90}) presents the most serious hazard.

The mechanism by which atomic weapon debris is disseminated is discussed. The theory leads to three kinds of fallout: first, local fallout, which is the

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1/ The radioactive debris which falls out of the atmosphere after a nuclear explosion is called the radioactive fallout.

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return to earth, during the first few hours, of the larger particles from the fireball; these include residues from the soil and structures which are swept into the fireball and either wholly or partially vaporized. The fraction of the total debris which falls out locally depends very much on the conditions of firing. The second type, tropospheric world-wide fallout, is the material which though not coarse enough to fall of its own weight in the first few hours is nevertheless left in the lower layer of the atmosphere, that is the troposphere. Although this fallout will in general move great distances, it stays near the latitude of the explosion and so leads to a band of radioactivity at the general latitude of the firing site. The fraction of the fallout which falls in this category depends mainly on the size of the explosion and the conditions of firing. The third type of fallout is stratospheric world-wide fallout. High-yield weapons thrust their radioactive clouds into the stratosphere and the material which does not fall of its own weight within the first few hours is then largely borne in the stratosphere for great lengths of time. An average time seems to be about ten years or somewhat less, corresponding to a half residence time of seven years (or less). Since the nuclear debris remains in the stratosphere for these long times, relatively complete mixing within the stratosphere should be obtained and one expects that the fallout from this source should be essentially uniform over the entire world. After passing through the tropopause into the troposphere it will be rained out rather quickly. Because of the long residence time in the air, this type of fallout is not a serious gamma ray hazard since Cesium-137 (Cs^{137}), the principal gamma emitter left after one year is relatively harmless.

Two years ago, it was estimated that there were about 24 megatons of fission products stored in the stratosphere corresponding (if it were all deposited uniformly on the earth) to about 12 millicuries of Sr^{90} per square mile and about the same amount of Cs^{137}.

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At the end of 1955 the total deposition in the upper midwest of the United States was some 13 mc/mi^2 of Sr^{90}. In the spring of 1956 this total rose to about 16 mc/mi^2.

Between May 5 and mid-July of this year, Operation Redwing was conducted at the Eniwetok Proving Grounds in the Pacific. Particular attention was paid to the fallout problem in this Operation and a major effort was made to produce a megaton-range weapon with an inherently smaller amount of fallout for a given energy release. This effort was successful. In addition, considerable attention was paid to operational factors which would minimize world-wide fallout. Thus, the total deposition in the stratosphere during this Operation was held to a figure very considerably less than that present in the stratosphere before the Operation. In fact, we estimate at the present time that the total stratospheric reservoir, counting all sources, is about the same as it was two years ago, i.e., about 12 mc/mi^2 of Sr^{90} or the equivalent of 24 megatons of fission products calculated as a uniform world-wide distribution. During the past two years the additional depositions in the stratosphere have amounted to about 6 megatons equivalent of fission products total or 3 mc/mi^2 of Sr^{90} or Cs^{137}. This appears to have compensated approximately for the 10 percent per year of fallout and the 2.5 percent per year of radioactive decay. In other words, the testing by all countries seems to have restored the stratospheric reservoir to approximately the 24 megaton value of two years ago.

The latitudinal tropospheric world-wide fallout, which is maximized by weapons of high-yield which do not puncture into the stratosphere, is increasing. Several such weapons have been air fired abroad in the last months. This material, for the reasons explained above, descends rather rapidly but all the way around the world in the same general latitude as the firing site. Thus, though it is difficult to estimate, it appears that this amounts to perhaps 5 additional mc/mi^2 of Sr^{90} and Cs^{137} in the U. S. Adding to this about ½ mc/mi^2 for the world-wide tropospheric fallout from the Redwing Operation and 1 mc/mi^2 for stratospheric fallout, we would estimate at present that a total of about 22 mc/mi^2 of Sr^{90} is to be

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found in the soils of the midwestern U. S., and that perhaps 15 to 17 mc/mi^2 is the total to be expected for similar latitudes elsewhere in the world, the difference being due to our proximity to our own weapons testing site in Nevada. These 22 mc/mi^2 of Sr^{90} in the soil of the U. S. amount to about 0.040 MPC2/ units in the top two inches of soil where most of the fallout is absorbed. Earlier, it seems reasonable to conclude on the basis of a plausible mechanism for the transport of radiostrontium from the soil to humans that the human body burden of Sr^{90} might well be as high as 70 percent of the concentration in the top soil on which people live; further evidence seems to indicate that this should be reduced to between 10 and 30 percent. Therefore at the moment we would expect, assuming that no further weapons are fired, that the body burden for children born now in America eventually would amount to between 0.004 and 0.010 MPC units. Consideration of the rate of transfer from the stratosphere to the ground and the rate of radioactive decay indicates that the body burden to be anticipated 15 years from now probably will be substantially the same as it is today.

New evidence has been found for the effect of rainfall on fallout by studying three particularly arid regions; in each case the amount of Sr^{90} in the soil was very much less than would be predicted from geographical location alone. Regions in which people normally live have enough precipitation so that differences in precipitation do not appear to affect the fallout by more than a factor of 2.

2/ As used in this speech one MPC unit is 1 microcurie of radiostrontium per kilogram of calcium, or 1 microcurie per average adult human, the "maximum permissible concentration."