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February 19, 1957

Memorandum for: Mr. Murray

Subject: SUNSHINE

The purpose of this memorandum is to summarize and to bring you up to date on the developments in the Sunshine Program and the Advisory Committee for Biology and Medicine's considerations of the problem from the time of the receipt of your memorandum dated February 7, 1956 requesting the ACBM to make a statement on the matter. In addition, I am attaching a memorandum summarizing the status of our studies of cesium 137 from weapons tests.

I apologize for not having specifically replied to your memorandum of last year, but I believe you understand that the situation with respect to Sunshine is so fluid that it has seemed unwise to press the ACBM at any precise moment to make what might be considered a final definitive statement. I appreciate your continuing interest in this problem and assure you that the Division and the ACBM are equally preoccupied with it.

At each of the ACBM meetings since February 7, 1956: namely:

55th - March 9 and 10, 1956
56th - May 26 and 27, 1956
57th - September 21 and 22, 1956
58th - November 16 and 17, 1956
59th - November 26, 1956 (Special)
60th - January 17 and 18, 1957

the Committee has discussed the problem of world-wide contamination resulting from weapons testing and at regular intervals the Division has presented it with the latest data available.

On November 26, 1956 the ACBM had a special session here in Washington devoted entirely to Sunshine at which you were present. Much of the discussion at that meeting was in relation to public statements which had been made October 12, 1956 by Commissioner Libby and November 15, 1956 by Mr. Eisenbud summarizing the data in hand at those times. Those statements you have seen, I believe.

As you will recall from your attendance at the ACBM meeting of November 26, discussions of the Committee were principally concerned with two rather fundamental questions. One was the validity of estimates of averages and maximum concentrations of strontium-90 in humans to be expected from past weapons tests, and the other was the validity of the maximum permissible body concentrations of strontium-90 recommended by the International Commission on Radiological Protection, the National Committee on Radiation Protection, the National Academy of Sciences, and the British Medical Research Council.

There was little quarrel with the estimated eventual average concentration from all detonations to date, of some two to four micromicrocuries of strontium-90 per gram of calcium in the skeletons of residents of the United States who are now young children. (This is the group which, because their skeletons are being formed at the peak of contamination from past detonations, would be expected to reach the highest burden of strontium-90). Rather, interest centered on the spread of values of concentrations to be expected as a result of variations in fallout, in availability of calcium in the soil and in average composition of the diet. Of especial interest were the maximum concentrations which might be expected, variously estimated as from 10 to 25 micromicrocuries of strontium-90 per gram of calcium: i.e., from 10% to 25% of the values considered by the ICRP, NCRP, NAS and BMRC to be acceptable limits for general populations.

Since the meeting of November 26, Dr. Kulp's latest data have come in, confirming an average as of 1956 of 0.34 to 0.7 micromicrocuries of strontium-90 per gram of calcium in younger children, depending upon whether or not one accepts Kulp's view that concentrations of strontium-90 in rib samples from children run twice as high as the average in the body as a whole. We are endeavoring to determine as rapidly as possible the validity of Dr. Kulp's extrapolation of this observation, made on older individuals under experimental conditions, to young children. In either event, the present average concentration in young children is less than one per cent of the recommended maximum permissible value.

There is a considerable spread in the data for children of a given geographical area. For example, from Texas, the area in which the highest average concentration (0.49 micromicrocuries of strontium-90 per gram of calcium for 13 children in the age group, 0 to 4 years) was reported, individual values ranged from about 0.02 to about 2.5 micromicrocuries of strontium-90 per gram of calcium. Because the samples of bone have been generally very small, we cannot say to what extent this spread in data represents actual differences in average concentrations of strontium-90 in the skeletons of individual children and to what extent it is due to variations within individual skeletons. This uncertainty points up the need for studies of distribution within the skeleton of the young child (for purposes of interpretation of data from relatively small samples of bone) as well as data from more children with, perhaps, the use of larger samples.

There was considerable discussion at the ACBM meeting concerning whether or not there is any discrimination in humans between strontium-90 and calcium from milk to bone. Dr. Comar's experimental data are now in hand and clearly indicate that in a single dose experimental situation there is discrimination against strontium-90, as compared with calcium, for deposition in the skeleton with a discrimination factor which may be somewhat less than two. Presently incomplete work at Mt. Sinai Hospital in New York suggests that in the case of daily increments of small amounts of strontium-90 the eventual discrimination, due to preferential removal of strontium, may be even greater, from three to six.

The question of the validity of recommended maximum permissible concentrations is fundamentally much more difficult. You will recall that the ACBM discussed whether or not concentrations higher by a factor of three than the recommended limit of 100 micromicrocuries of strontium-90 per gram of calcium might be acceptable. While the Committee reached no definite conclusions on this subject, some of the members expressed the belief that, if considerations of national security were to make the question a more pressing one, higher levels would be appropriate.

The nature of the problem of acceptable environmental levels of radioactive contamination is such that any limit is subject to controversy. This aspect is illustrated by discussions of genetic implications during the past few years. Geneticists generally believe it probable that exposure of the germ cells to radiation increases the average rate of genetic mutation by an increment proportional to the average radiation dose received, no matter how small that dose may be. Whether or not this extrapolation from observable genetic effects is valid, at our present level of understanding of biological processes one must admit the possibility that for any level of radiation dose, no matter how low, the impact on human welfare may not be absolutely zero. On the other hand, one cannot deny the possibility that at or near environmental levels of radiation in which the biological species have evolved, the overall effect of radiation may be beneficial to the species. In any event, the nature of the problem invites wide differences of opinion in efforts to evaluate the significance of genetic effects which may occur at low levels of exposure.

The evaluation of other hazards of exposure to radiation at low levels involves similar considerations. There is conflicting evidence in the matter of whether or not the lowest of radiation doses may reduce life expectancy by very small decrements which depend on the magnitude of the dose. Many of our best informed radiobiologists believe that there are almost certainly levels of cumulative dose below which exposure to radiation will not increase the incidence of leukemia, cancer, or aplastic anemia above that which would otherwise occur. Limitations in our knowledge of the mechanisms of production of those diseases, however, do not permit us to deny the possibility that small doses of radiation may produce correspondingly small increases in the probability of occurrence of one or another of these diseases.

This situation is not peculiar to radiation but applies to many aspects of our way of life, most of which are generally accepted without question. Although the hazards of radioactive contamination in the range of levels under consideration are almost certainly very small by any standard of measurement, the acceptance of any degree of contamination can be made a controversial subject. This is particularly true when the reasons for contamination of the environment involve questions which are themselves controversial, such as the development and use of nuclear weapons, optimum measures for national security, and international relations.

We are working toward reductions in the degree of uncertainty as to the human uptake of strontium-90 from calculable environmental conditions and

with respect to the upper limits to the biological effects which might conceivably result from low concentrations of strontium-90 in the body. It is improbable, however, that within a period of one or two or three decades we can eliminate our uncertainty as to whether or not exposures to low levels of radiation, no matter how small the dose, may produce correspondingly small changes in rates of genetic mutation, in reduction of life expectancy, and in incidence of leukemia, cancer, and aplastic anemia.

The considerations discussed here are not new factors in the field of radiation safety. It is common practice to advise that exposure to radiation should be limited to the lowest practicable values or, more loosely, that unnecessary exposure to radiation should be avoided. In AEC operations, exposures of employees to radiation have been rather consistently limited to small fractions of maximum permissible levels. Nevertheless, since one cannot express in brief and simple language the factors involved in establishing recommended maximum permissible levels, we resort to the use of such expressions as "safe" and "unsafe" levels. The term "safe" implies absolute freedom from hazard, although in practically all situations to which the term is commonly applied, there is only relative freedom from hazard. For a number of reasons statements concerning radiation safety are now receiving such detailed critical analysis that it appears desirable, in order to prevent misinterpretation, to avoid the use of the term "safe" without some qualification. Rather, it may be more useful to talk about the possible effects of radiation along with reasons for accepting small exposures to radiation whether in connection with national security or with peaceful applications of nuclear energy.

In short, the AEC appears to be faced with the necessity for educating the public--scientific, political, and man-on-the-street--in more realistic concepts of the relation of man to his environment. Meanwhile, we must and we are endeavoring to refine our knowledge of the relationship of dosage to a particular biological effect in order that our concern over the health of present and future populations may result in more precise definitions and estimates of the true biological risk inherent in very low levels of exposure to radiation.

Charles L. Dunham, M.D.
Director
Division of Biology and Medicine

Enclosure
Report - Cesium-137

cc: To each Commissioner
cc: General Manager
cc: ATammaro, AGM/RID
cc: Secretariat

CESIUM-137

The following is a summary of the information on cesium-137 from fallout as given the ACBM at their meeting of January 17-18, 1957.

From time to time we have had occasion to review early estimates that the long range effects to be anticipated from radioisotopes other than strontium-90 in fallout from nuclear weapons are secondary to those from strontium-90. A little more than a year ago Drs. Marinelli and Miller of ANL, by use of a "whole body" counter, demonstrated that the human body content of cesium-137 is sufficiently high to be measured and that persons from different geographical areas have comparable body content of this isotope. Following these observations, Drs. Anderson and Langham have used the Los Alamos whole body counter to measure concentrations of cesium-137 not only in humans but in samples of meat, milk, and other foods.

Since the total body content of humans can be estimated on the basis of gamma radiation reaching the counter, with little inconvenience to the person, studies of body content of cesium-137 are comparatively simple. Expressed as fractions of recommended maximum permissible concentrations in the body current levels of cesium-137 are considerably less than those of strontium-90. Comparative measurements of cesium-137 and potassium-40 in the human body indicate that, at the present time, the radiation dose rate due to cesium-137 is only about 0.03 of that due to the potassium-40 which occurs naturally in the body. The close chemical similarity of cesium to potassium, leading to a similar distribution on the body, makes this comparison especially significant.

The fact that cesium is eliminated much more rapidly from the body (average retention between 140 and 200 days) and that the apparent source of cesium-137 in the diet is fallout retained on vegetation or dissolved in surface waters rather than cesium-137 deposited in the soil, lead us to believe that body levels of cesium-137 from tests to date have already reached their peak, whereas average values of body content of strontium-90 are expected to increase for some time. Dr. Marinelli informs us that there has been no increase in values of body content of cesium-137 during the past year.

Dr. Langham has suggested that, because the cesium-137 content of milk appears to be largely due to recent fallout retained by vegetation and surface water and because of the ease with which measurements of cesium-137 in samples of milk as small as 20 pounds can be made in the "whole body" counter, measurements of cesium-137 in milk may prove to be a relatively convenient index of current rates of fallout of residual fission products, particularly strontium-90, from the stratosphere. Possible correlation between concentrations of cesium-137 in milk and rate of fallout of strontium-90 is being investigated at both Los Alamos and the NYOO HASL. Observations by Dr. Lyle Alexander, Dept. of Agriculture, of large variations in the cesium-137 content of samples of powderedmilk taken from the output of a large processing plant at frequent intervals within a single day suggest that the relationship between the occurrence of cesium-137 in milk and rate of fallout may not be simple.

Although we do not expect cesium-137 to approach strontium-90 in importance as a factor in the possible effects of nuclear weapons, we are initiating further studies of the biochemical behavior and biological effects of cesium-137 in animals at both Los Alamos and Argonne.