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FOLDER Fallout

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FALLOUT

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Date: 4/15/57

OFFICE OF COMMISSIONER W. F. LIBBY

To: H. S. Traynor

Per telephone conversation.

W. F. Libby

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Remarks Prepared by Dr. Willard F. Libby, Commissioner
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RADIOACTIVE FALLOUT FROM NUCLEAR TESTS

FALLOUT FROM TESTS

There is a great deal we do not know about the precise effect of radiation on the human body, but we do know that the effect of radioactive fallout from nuclear tests is not, nor is it likely ever to be, the danger to the human race in this generation or in later generations which many people have been led to believe.

Long before nuclear weapons were even thought of, in fact, ever since people have lived on this planet, they have been subject to radiation from cosmic rays and from the radioactive material in the crust of the earth. In recent years has been added radiation from the use of X-rays, from luminous devices, etc.

Let us compare radiation from test fallout with radiation from some of the other sources which have been with us through all times so that we may better evaluate fallout as an element of danger. Cosmic rays, which come from outer

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space, have their radiation effect progressively diluted as they pass through the atmosphere surrounding the earth. Thus, the person living in Denver, Colorado, at an altitude of about 5,000 feet receives a dosage of cosmic rays approaching double that of a person who lives at sea level.

At the present time, the radiation dosage to bone from the most worrysome part of radioactive fallout, which is Strontium-90, is about the same as what the Denver resident would receive as additional radiation from cosmic rays if he moved from Denver proper about 200 feet up on the mountainside, or to the resident at sea level if he moved from the beach to the top of a hill 300 feet high.

More exactly, and using the measure commonly used for radiation exposure, the roentgen, which is an amount equal in the chest to six to ten chest X-rays--at sea level in our latitudes we receive 37 thousandths of one roentgen each year from cosmic rays, while people living at Denver, Colorado, at an altitude of 5,000 feet receive 60 thousandths of a roentgen annually. Now, in order to compare fallout we must put all items in the same terms.

FALLOUT AND RADIOACTIVE STRONTIUM

At the present time, the radiation effect on human bones from radioactive strontium, the most worrisome part of radioactive fallout, is about 1.5 thousandths of a roentgen annually--about one-fifteenth of the difference between the cosmic ray dosages at sea level, and at 5,000 feet elevation, or equal to the extra cosmic rays at the extra height of about three hundred feet.

Radioactive strontium does not occur naturally but is produced by nuclear reactions. It also has a natural tendency to stay in our bones and thus to irradiate them. How much does it amount to? As just stated, the most recent data show that children in the United States have about 1.5 thousandths of a roentgen annually of extra bone exposure from the radiation from radioactive strontium.

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Adults have much less because their bones grow more slowly. This country has somewhat higher rates than elsewhere because of our tests in Nevada.

The effects of irradiation of bone are bone tumor and leukemia. How much hazard does the bomb test radioactive strontium constitute? This is a difficult question to answer with complete certainty for the amounts which cause these effects are not well known, but we do know that the dosage is much less than the extra cosmic ray dosage at 5,000 feet altitude as compared to sea level. We have examined the vital statistics on these dread illnesses to see whether there is a higher rate for populations living at 5,000 feet than for those living at sea level in order to get from these data some direct notion about the magnitude of the effect. There is no evidence of any observable effect of the extra radiation in these numbers. The average annual incidence of bone cancer at both levels was about 2.8 per 100,000 people in 1947, and for leukemia, the average was about 7. The actual numbers were:

Occurrence of Bone Cancer and Leukemia
(New Cases Per Year Per 100,000 Population.)

	Bone Cancer	Leukemia
Denver	2.4	6.4
New Orleans	2.8	6.9
San Francisco	2.9	10.3

(Figures obtained from National Institutes of Health, Department of Health, Education and Welfare)

Since excessive doses of radioactive strontium are known with certainty to cause both bone cancer and leukemia in animals, we must not deprecate or casually dismiss the possible results of a widespread, but low intensity, effect in causing these disabilities. However, by using normal experience insofar as it is applicable, we can orient ourselves with respect to this new factor in our environment--

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much as we do for other results of our modern way of life. We cannot see any effect of a radiation dosage fifteen times the present test fallout dosage in large populations, but the number of cases of bone cancer and leukemia each year, even in the large cities, is small so our data may not be too significant. However, these figures do point to a definite tangible evidence of a margin of safety.

Perhaps more pertinent, though less direct, is the result of animal experimentation and the rare human experience on the effects of radiation in causing bone tumors and leukemia. The official tolerance limit for people working in atomic energy plants and with radioactivity professionally is 2,000 times the present bone content for children in the United States, and about 10,000 times that in adults. However, it has been recommended by high scientific authorities that the tolerable amounts of radioactive strontium for the population in general should be only one-tenth of those acceptable for workers who of course expose themselves voluntarily. On this basis the present level in children is 1/200 and, in adults, about 1/1000 of this maximum permissible concentration for large groups of people. Perhaps a word of explanation of these tolerance or maximum permissible concentration limits would be helpful. When scientists speak of "risk" or "hazard", they do not use the words in the same sense that most laymen regard them. Scientists try to be precise; they measure such things almost to the limits of the finite; therefore, "risk" means possible effects far beyond the range of the probable or detectable. The maximum permissible limits do not mean that above those limits one encounters trouble--but rather that perhaps only a ten-fold larger concentration would give effects which would be definitely detectable.

WHAT ABOUT THE FALLOUT STILL IN THE STRATOSPHERE?

If all the radioactive fallout which still is airborne should come down suddenly, there would be about one-third more total radioactive strontium on the ground than we now have here in the United States. It falls so slowly,

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however, that there is expected to be relatively little increase over the present amount deposited--the extra fallout just about compensating for the natural radioactive decay of the radiostrontium already deposited. (The radioactive decay occurs at the rate of 50 percent every 28 years.) The ground level will remain about constant for the next ten years and then drop off at the rate of about 2.5 percent per year due to radioactive decay uncompensated by further fallout from the upper atmosphere. Therefore, in the United States the present level is about as much as we shall ever have from tests already fired.

WHAT ABOUT POSSIBLE GENETIC EFFECTS?

Radiostrontium is not the only fallout product of nuclear bombs. In fact, there are dozens of others but, for one reason or another, these fail to accumulate inside the body as radiostrontium does. However, certain of these other fallout materials do emit penetrating radiation which can irradiate the body from the outside and thus possibly can have effects on the health and can produce genetic mutations. In fact, for early fresh fallout close to the site of a nuclear explosion, this radiation of the body from the outside is the principal hazard, and it is only later on that radiostrontium becomes important. There is one short-lived form of radioactive iodine which is assimilated into the thyroid gland so it is not quite correct to say that no internal irradiation occurs from early fallout, but the external radiation certainly is the main hazard with which the United States Government is concerned in planning protection against enemy nuclear bombs. Later on and far away from the test site, months and years afterwards, there still is some external radiation which does amount to a detectable total and it is this radiation which raises questions.

We are continually being bombarded by radiations not only from the cosmic rays from outer space--the cosmic rays mentioned above--but from the earth and even from our own bodies. Following our previous tactic of comparing these new fallout effects with normal experience insofar as

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it is justified, we now compare these external radiation exposures with those normally encountered. The external radiation doses from test fallout have averaged between 1 and 5 thousandths of one roentgen per year during the last three or four years. Now, this is to be compared with a normal dosage from ourselves and our environment of 150 thousandths of a roentgen per year. Therefore, we conclude that the radiation dose from test fallout is relatively very small, but the question remains: "Small as it is, does it have genetic and health effects?"

The direct experience which we have had on health effects is reassuring. We do not see that the much larger dosages received by people living in the higher altitudes or in localities which are particularly radioactive have had noticeably bad effects--the effects expected are cancer and shortening of life. However, it may be that small effects do occur which because of their smallness are difficult to see. The only definite thing we can be certain of is that test fallout is very small as compared to natural dosages and, therefore, we know that the effects must not be very far outside of normal experience. One environment can differ from another in natural radiation intensity by much more than the total fallout. For example, a brick or concrete house can easily have enough natural radioactive material in the walls to give up to 40 thousandths of a roentgen per year more exposure than a wooden house--this is between 8 and 40 times the annual dosage from test fallout. The genetic effects are much more difficult to consider since they will show up only in later generations and, most importantly, only when both parents have been effected either directly or through affected parents. But by study of animals and plants we know that radiation does produce genetic changes--we even irradiate plant seeds in order to speed up the rate at which new forms appear so superior new plants can be produced by selection of the few desirable ones and cultivating them in the way Luther Burbank developed so many useful new plants using just those naturally occurring forms. However, most of the forms from the irradiated seeds have inferior properties and it is only a rare one that is a definite improvement on the original plant. Similar results are found with animals so we guess that human beings probably are subject to same type of effects. Therefore, we believe that there

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must be some genetic effects of test fallout radiation but, again, from our normal experience in which no effects of high altitudes versus low, or brick versus wooden houses, etc., have been observed, we know that the effect must be very small. The laboratory experiments on plants and animals agree with this, but do insist that there must be some very small effect, although it will be entirely undetectable from test fallout.

WHAT ABOUT FUTURE TESTS?

Continued testing at the same rate and in the same way as during the last five years will not increase the hazard on a straight additive basis since an equilibrium will be established between additions of radioactivity and radioactive decay. For Strontium-90, the maximum factor of increase possible is eight-fold and the external radiation exposure outside the immediate test area would behave similarly. In 1980 it would be four times the present and, in 2011, about six times, and so on until after a very long time it would approach the factor of eight.

The cause for real concern is not the deleterious effect of radiation resulting from weapons tests, but rather what would be the effect of the infinitely greater amount of radiation which would result from the massive use of nuclear weapons in warfare. Here we would be dealing with excessive radiation, not to all the people of the world as has been suggested, but quite probably to large numbers of people residing in areas of substantial contamination. With regard to the people so overexposed, there would be serious increases in the pathological effect of excess radiation, such as cancer and leukemia. There would, also, be the genetic effect which would manifest itself in the children and the children's children of such people.

In nature, there are mutations in plants, in animals, in human beings. Some mutations show superior characteristics and these make it possible for us to develop superior strains, but unfortunately most mutations are harmful rather than beneficial. For this reason and because their effect is not

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limited to one generation, the genetic effects of excessive radiation may be more important than the pathological effects.

If radiation--from weapons test fallout, from natural sources, from the normal use of X-rays--is all measured in quantities so minute as to have very small effects on either present or future generations, we should concentrate our concern on what would happen if the world should engage in a nuclear war, for therein lies the real danger to mankind.

It is not contended that there is no risk, however minute. But all life, and every minute of our day and night, is measured in terms of risk--40,000 highway deaths each year in this country, accidents in the home, etc. We make our choice: How much risk are we willing to take as payment for our pleasures (swimming at the seashore, for example), our comfort, or our material progress? Here our choice seems much clearer. Are we willing to take this very small and rigidly controlled risk, or would we prefer to run the risk of annihilation which might result if we surrendered the weapons which are so essential to our freedom and our actual survival.

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