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SUMMARY OF 1957 FALLOUT HEARINGS

SYMBOL: BM:CLD

The following is developed in response to your request for a brief analysis of the Fallout Hearings of 1957 covering objectives and scope, expressions of desire on the part of the JCAE for AEC action, commitments made or implied by AEC, and formal recommendations coming from the Hearings with associated subsequent actions by AEC to carry out the recommendations.

The most important document relating to the 1957 Hearings is a 19-page Joint Committee Print entitled "SUMMARY-ANALYSIS OF HEARINGS May 27-29, AND JUNE 3-7, 1957 on the NATURE OF RADIOACTIVE FALLOUT AND ITS EFFECTS ON MAN," dated August 1957. A copy is attached. As this document noted (p.1), "It was the intent of these hearings to emphasize the scientific subject matter related to the fallout problem, and to leave broader policy issues to subsequent consideration." Throughout the 2216 pages comprising the Hearings record, therefore, remarkably little discussion of policy or program or actions to be taken by AEC actually occurs. The last day of the Hearings was devoted to a discussion of the research program, but for the most part, except as noted below, the discussion was narrative.

The printed record of the Hearings contains not only the testimony of the many outstanding scientists who appeared before the Special Radiation Subcommittee of JCAE, and statements submitted by them for the record, but also a large amount of supplementary material gathered by the JCAE staff. In the Summary Analysis (p.1) the following note appeared: "The hearings, including material introduced for the record and a comprehensive bibliography, will probably be the most extensive library of information on fallout yet to appear in one document." The Hearings really covered not only the production and dissemination of fallout but also the biological effects of radiation in general. The following, quoted from the Summary-Analysis (p.1) is a statement of the accomplishments of the Hearings that I think is completely factual:

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The hearings covered in detail the whole cycle of fallout from its inception in the detonation of nuclear weapons, through its scattering about in the atmosphere and descent to earth, and finally its uptake by and effect on human beings, animals, and vegetation. Testimony covered a breadth of scientific knowledge from physics to pathology, and from geology to genetics, as it relates to fallout. Some 50 experts from the major scientific areas involved were invited to present testimony before the committee and submit statements for the record. All sessions were open to the public.

The hearings accomplished several things. One thing was clarification of many important scientific points. Another was putting into better perspective much of the available, scientific data on fallout. Most helpful, in this respect, were experimental round-table discussions among some of the expert witnesses. The discussions helped to point up the areas of agreement and to outline more clearly the areas of continuing disagreement.

The hearings served to bring out distinctions that must be made between fact and value judgment, and served to emphasize how difficult it is to give precise scientific definition to such words as "clean," "safe," and "hazardous," so that these words acquire exact meanings.

The Joint Committee (Summary-Analysis, p.2-3) noted several points of what might be termed general agreement about the basic nature of fallout and its effects:

1. Origin of fallout--It was pointed out that all nuclear explosions can be expected to produce some radioactive materials. However, certain kinds of explosions produce very much less radioactivity than others. Although there is no such thing as an absolutely "clean" weapon (that is, there is no such thing as a weapon detonation completely free of accompanying radioactivity), the amount of the radioactivity produced can be substantially altered in relation to the size of the explosion.

Here I believe they are equating radioactivity with fallout. It is interesting to note that although there were a number of references to production of carbon-14 (which is produced as radioactive carbon dioxide), no appreciable significance was attached to this from the standpoint of hazard. Since the Hearings the matter of the hazard of C-14 has come up and the Division of Biology and Medicine has issued WASH-1208 (reprinted in Science) on this subject.

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Distribution of fallout - There was substantial, but far from complete, agreement on what happens to radioactive debris produced in man's environment, how much is there now, and how and where it is distributed, and how much is in man himself. There was considerable evidence presented to indicate that in no part of the atmosphere is fallout uniformly distributed and that, therefore, the effects of fallout on the world's population could not necessarily be expected to be uniform.

Presumably by now the degree of uncertainty has been reduced somewhat, although it is still large. Measurements on how high the levels are are certainly more plentiful now than two years ago.

Biological effects of radiation--There was general agreement that any amount of radiation, no matter how small the dose, increases the rate of genetic mutation(change) in a population. There was, on the other hand, a difference of opinion as to whether a very small dose of radiation would produce, similarly, an increased incidence of such somatic (nongenetic) conditions as leukemia or bone cancer, or a decrease in life expectancy, in a population.

Discussions this time should serve to point out that the difference of opinion for somatic effects continues to exist and that the agreement on the linear relationship between dose and genetic effect regardless of dose rate may be slightly less emphatic now than two years ago.

Tolerance limits--There was general agreement that there is a limit to the amount of radioactivity and, hence, to the amount of fission products that man can tolerate in his environment. The extent to which existing and future generations will be affected by manmade radiation was shown to be intimately tied to certain decisions, moral as well as scientific, that must be made as to how much radiation can be tolerated by the people of the world.

Now that the groundwork may be presumed to have been laid (by the last Hearings), I think it is reasonable to suppose that the whole question of tolerance limits will not only be taken up more strongly this time but that indeed the JCAE will expect a more definitive approach by the AEC toward this subject, which mixes science and policy.

Effects of past tests--It was clearly shown that man's exposure to fallout radiation including strontium-90 is and will be in general small, for the testing already done, compared with his exposure to other, "normal background" sources of radiation (a fraction of 1 to 10 percent), and even compared with variations

in "normal background" sources. But it was not agreed on how this information should be interpreted.

Effects of future tests--There were differences of opinion on how to forecast the consequences of further testing. The differences hardest to reconcile appear to be those concerning the biological effects of radiation. Pending a resolution of differences, it would appear from the information presented that the consequences of further testing over the next several generations at the level of testing of the past 5 years could constitute a hazard to the world's population. It is very difficult, if not impossible, to forecast with any real precision the number of people that would be affected.

Suffice it to say that undoubtedly the question of the effects of testing will come up again. It will be difficult to discuss the effects of future testing, if any, without making it appear that AEC is planning to continue testing as a matter of policy.

Effects of nuclear war--The catastrophic nature of the radiation effects from a multiweapon (atomic and hydrogen bombs) attack on the United States were clearly portrayed. This, of course, could be applied to any nation.

The Joint Committee (Summary-Analysis, p. 3-4) then presented a summary list of "major unresolved questions":

1. How "clean" can nuclear weapons actually be made? The solution to this question lies in the future of weapons development.

It is unfortunate, of course, that the term "clean" ever was used in this connection, and it is to be hoped that the issue does not arise in these new hearings. Nevertheless, a number of points have yet to be made about "clean" weapons, the primary one being that an arsenal containing weapons whose radioactivity-products can be varied in amount for a given yield is an arsenal better equipped than one not containing such weapons.

2. To what degree is the distribution of radioactive fallout uniform or irregular throughout the world? Vigorously conducted sampling programs will help to answer this question.

Here, the AEC will almost certainly be quizzed as to whether our sampling and analysis program has been vigorously conducted. Ample evidence of available data and its value should help to answer this question. Concerning uniformity, the following situation seems clearly established:

- (1) The deposition of fallout strontium-90 (on the ground is unquestionably non-uniform.

- (2) The vertical and horizontal distribution of fallout Strontium-90 in the stratosphere is probably non-uniform, although considerable uncertainty still exists because of the difficulty in obtaining the measurements.
- (3) Whether or not the material in the stratosphere is uniform, it is highly doubtful that it falls out uniformly. That is, the fallout itself--from the stratosphere--probably is non-uniform.

It is to be hoped that before the new hearings, the differences in opinion between Dr. Libby on the one hand and Dr. Machta, Dr. Martell, and the BOD people on the other can be minimized.

Concerning stratospheric residence time (not mentioned in the "unresolved questions"), even in the 1957 Hearings no one seriously debated the proposition that the half-life in the stratosphere was not on the order of 7 years (plus or minus several years), i.e. that the mean life was not 10 $\frac{1}{2}$ 5 years as stated by Dr. Libby up to that time.

3. To what extent do the biological processes of plants, animals, and human beings--under normal conditions--exhibit a preference for or "discriminate" against strontium-90 and other potentially hazardous isotopes that are taken up into the human body? Sampling and metabolic studies underway will develop a better answer to this question.

Summary testimony this year should pretty well lay this question to rest. Unfortunately, another question has arisen since 1957: how important is direct leaf deposition (vs. uptake from soil)? Some progress has been made since 1957 both in this country and in England concerning the mechanisms by which field crops become contaminated and concerning the behavior of fallout contamination in soils.

4. Is there a "safe" minimum level of radiation or "threshold" below which there is no increase in the incidence of such somatic (non-genetic) conditions as leukemia or bone cancer, or no decrease in life expectancy, in a population, resulting from radiation? The answer to this question appears difficult to find experimentally.
5. What is the genetic "doubling dose" of radiation to man? That is, what dose of radiation will cause the spontaneous genetic mutation (change) rate to double?

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These questions are, of course, no more answered now than in 1957, which is not to say that progress in basic biological understanding hasn't been made. But the JCAE should not be expecting answers and I will be surprised if they do. This is because I was able to convince the Committee in 1957, along with others who testified on the same point, that the answer here would not come overnight. Nevertheless, in two years there has been some real progress that can be reported, especially along the lines of showing that biological effects of radiation are dose-dependent (a fact which, if the only one to be considered, would deny the strict "linearity" regardless of dose rate hypothesis).

6. Should a distinction be made between absolute numbers of persons affected by fallout and percentages relating these numbers to the total population of the world, i.e., can we accept deleterious effects on a relatively small percentage of the world's population when the number of individuals affected might run into the hundreds of thousands? This question cannot be answered by considering scientific data only. Overall national policy and great moral issues are also involved.

This question obviously is rhetorical, for the answer is "yes" and the data should be reported "both ways."

Before turning to a more detailed discussion of the Hearings, the JCAE (Summary-Analysis, p.4) had this to say about the "need for further research":

There was strong agreement among the witnesses that even greater efforts and even larger budgetary outlays, both private and governmental, are required for our research program in the sciences related to fallout. There was testimony advocating sharp increases in budget, with emphasis in specialized fields. There was also testimony for more gradual long-term increases with emphasis on stability and continuity. But most witnesses appeared to feel that some increase is necessary if we are to accomplish our objectives of understanding the nature of radioactive fallout and its effects on man at an earlier date.

The research program was discussed further by the Committee (Summary-Analysis, p. 17-18), a part of which is quoted below:

A well-balanced program exists now in the AEC's Division of Biology and Medicine (Dr. Charles L. Dunham, Director), according to testimony given. A well-balanced program as the primary need for the future was

also spoken for. In particular, there was testimony advocating that long-term basic research not be lost sight of in a multitude of short-lived programmatic research projects. Many specific proposals for research projects appear in the record.

Although the testimony expressed satisfaction with existing research programs, the general tone seemed also to advocate a stepped up program for the future. Part of the reason for the stepping up, it was pointed out, is that past programs have borne fruit; many specific unknowns have been discovered, which new effort can be put on.

Some of these areas for further research are--

1. The behavior of particulate matter in the atmosphere, particularly the stratosphere;
2. The absorptive capacity of the biosphere for fallout products such as strontium-90;
3. The selectivity of biological systems for particular isotopes;
4. The response of biological systems to low doses of radiation;
5. The application of biological knowledge obtained from an experiment on an individual to large populations and vice versa.

AEC has, you will recall, developed its plans for expansion of the Bio-medical research program (AEC 604/35), tied primarily to fallout needs. A letter notifying JCAE of this program was sent to Mr. Ramey on October 1, 1958, and--following inquiry by the JCAE--a further letter giving a considerable amount of back-up information on program and budget was sent on February 19, 1959. If the Congress gives us what we have in the 1960 budget, then we will have accomplished the first steps in an orderly expansion. Testimony in the Hearings said "during the next three years (expansion by) some 50% to be followed in the following three years by another 50%."

The JCAE (Summary-Analysis, p. 18) commented on manpower and education:

Manpower and education of manpower are emphasized often. To talk of programs without thinking of the manpower to carry them out was deplored. In fact, a recommendation was made that the AEC emphasize manpower education and development in the biological and associated sciences.

Our record here is not bad. We have expanded the three existing special fellowship programs in radiological physics, industrial medicine, and industrial hygiene. We have developed a program for granting funds for buying equipment for training in radiation biology in colleges and universities. We have developed jointly with NAS our program of summer institutes in biology.

The JCAE (Summary-Analysis, p. 18-19), as might be expected, bore down heavily on the question of information availability and exchange. Its comment was mixed in tone:

Information availability and exchange

One point the committee was interested in was whether or not scientists, many of whom are employed by Government agencies, felt free to work, and to exchange information in the sciences related to fallout. The weight of the testimony was that such freedom exists.

Another point the committee was interested in, and one on which the testimony is not so satisfying, is whether or not information on fallout and its effects is reaching the public. Information on the biological effects of radiation, from whatever source, has been presented to the public in widely read reports by the British Medical Council and by the National Academy of Sciences. These reports contain some information directly applicable to the fallout question. But information on fallout itself has evidently not reached the public in adequate or understandable ways. That this is so is evidenced by the need for, the results of, and the interest in these hearings.

These hearings do not contain significant amounts of scientific data discovered just for the sake of the hearings. If such information that was new was made available as a result of the hearings, this occurred for principally one of two reasons:

1. The progress of research is so rapid that new information developed in late 1956 and early 1957 was ready for initial presentation at the hearings.
2. The information already existed but had not been made available generally.

And there should be no doubt that much new information was made available. Information was disclosed as follows:

- (1) Concerning the work by weather people on predicting fallout patterns and, in particular, concerning the mechanisms of nonuniformity of stratospheric fallout;
- (2) Presenting the results of soil sampling and assaying from around the world, confirming the nonuniformity of existing fallout;
- (3) Concerning past testing activities in Nevada in far greater detail than had generally been known to be available;
- (4) Concerning the "clean" weapons situation;

- (5) Concerning the importance of strontium-90 in local fallout;
- (6) Concerning the importance of countermeasures and the need for operational information (this point will be discussed below);
- (7) Concerning the most recent evaluations of what the best values for ground-to-bone strontium-90 discrimination factors should be;
- (8) Concerning the behavior of strontium-90 in soils;
- (9) Concerning the question of threshold effects, "detectable" effects, and maximum permissible concentrations;
- (10) Presenting, in spite of disagreements, quantitative estimates of future radiation levels.

And finally, the JCAE as a parting shot noted the following as their final paragraph of the Summary-Analysis:

The need for operation information

The result of a research effort is information. But this information is not necessarily directly applicable to solving a problem. For example, the newly issued handbook, The Effects of Nuclear Weapons, prepared by the Department of Defense and the Atomic Energy Commission, covers at length the effects of single weapon explosions of varying sizes and under varying conditions.

It is apparent, however, that the people of the world and their governments lack information on the operational problems--meaning information that can be acted upon in a given situation--associated with fallout. A generalized way of stating these operational problems is to pose the question: How can men survive in, and how can he respond to, an environment of increasing manmade radioactivity in peacetime and in wartime? Further information of this operational sort appears to be clearly needed covering--

First, industrial and weapons sources of radioactive contamination and radiation during peacetime;

Second, nonmilitary protection, survival, and recovery measures in wartime and in the postwar period.

In the context of possible civil defense hearings, workmen's compensation hearings, and the like, this section should not be taken lightly.

I think you should keep in mind that we in the AEC were given the opportunity to comment, informally, on the Summary-Analysis before it was finally published. While the responsibility for the document clearly belongs to the Committee, it would nevertheless probably not become us to take issue with it very strongly.

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Fortunately, there appears to be little reason for doing so, for in general the document is an objective appraisal of an extremely complicated subject. It did not discredit the AEC nor the JCAE.

cc: Deputy General Manager

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