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IONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE
WASHINGTON 25, D. C.

SDC

This CRITique was prepared by Geo. Spiegel and provided to all embassies abroad. Many have requested additional copies for use of embassy staff.

It is a rather good job. Differences between NAS and MRC are not ignored, though they are minimized.

CC

8/23/56

Dr. Bronk -

Analysis of BEAR reports, prepared in the State Department. I have not read it, but Charles' comments are attached. It has gone to all U. S. embassies abroad.

SDC

NAS - Goals Simplified

ENCLOSURE 1

CRITIQUE OF THE REPORT OF THE NATIONAL ACADEMY OF SCIENCES

The Biological Effects of Atomic Radiation

Based on (1) "A Report to the Public," and (2) "Summary Report."

To understand and best evaluate the implications of this report it is important to bear in mind the background of the individual scientists who made the study and their relationship to the National Academy of Sciences-National Research Council and to the Government.

The NAS-NRC is not a Government organization. True, it was established by President Lincoln in order to have a distinguished body of scientists with whom the Government could consult at the time of the Civil War. On the other hand, it is a self-perpetuating body of free American scientists who control the membership of the Academy without any Government appointments. While various Federal agencies may appoint representatives to the various divisions of the National Research Council (the operating body of the NAS), they serve to bring problems to the Council for advice, and not to control the actions or the opinions of Council.

In the case of this study, the President of the NAS, Dr. Detlev W. Bronk, called together some 100 American scientists to carry out the study as individual citizens. While some of the scientists were Government employees and top advisers to Government on scientific matters, they were not acting in these capacities in their participation in the study.

The study was undertaken largely as a result of the concern felt throughout the country following the March 1, 1954 thermonuclear test explosion at Bikini, as a result of which a number of Marshall Islanders and Japanese fishermen were irradiated by fallout debris from the explosion. Subsequently, a number of scientific bodies in the U.S. passed resolutions requesting that a study be made of the possible effects on the human race of continued nuclear weapons testing.

NAS

In April, 1955, the Rockefeller Foundation provided the NAS with funds for undertaking a very broad study of the effects of atomic radiation. The subject reports are the final fruits of this study, which will be a continuing one.

Whereas the AEC has always been aware of the possible hazards from fall-out from surface bursts of atomic weapons (see "Effects of Atomic Weapons", 1952), it had been even more aware of possible hazards to nearby livestock and the public generally from serious accidents which could conceivably occur to large pro-

duction reactors such as those at the Hanford Works. The Bikini fallout incident made it abundantly clear that fallout was important from the standpoint of continued weapons testing and as a factor in civil defense planning. The problem of radiation effects has been under continuing review by the AEC and by the joint U.S., U.K. and Canada Tripartite meetings. In addition, the AEC has contributed a major portion of the basic scientific data for the deliberations of the National Committee for Radiation Protection and the International Commission for Radiation Protection.

A few words are in order on the general approach of the NAS study committees. They did not include an evaluation of the effects of an atomic war. As Dr. Bronk stated in the press conference of June 12, 1956, he could not define an atomic war so he asked the committees to limit themselves to peacetime atomic energy activities including weapons testing.

In the Foreword to the Summary Report, Dr. Bronk stated: "The use of atomic energy is perhaps one of the few major technological developments of the past 50 years in which careful consideration of the relationship of a new technology to the needs and welfare of human beings has kept pace with its development. Almost from the very beginning of the day of the Manhattan Project careful attention has been given to the biological and medical aspects of the subject. By contrast, the automobile revolutionized our pattern of living and working but we are only now beginning to appreciate the problems of safety, urban congestion, nervous tension and atmospheric pollution which have accompanied its development. In the same way, the development of the aircraft industry outran our knowledge of how to meet the environmental needs of the human beings it intended to transport through the skies." NAS

The scientists, save for the geneticists, were all persons who had actively participated in the past in the efforts to reduce industrial toxicological hazards, air pollution, stream and harbor pollution, and soil and crop pollution, and destruction which has occurred with developing industries largely uncontrolled until serious damage had already taken place. They are determined that with a much greater body of knowledge to draw on concerning radiation effects, similar situations will not arise as a result of the rapidly growing atomic energy industry with its even greater potential dangers.

Consequently, once they had assured themselves on two points, namely: weapons testing at the present rate and with present safeguards was not a present menance, and the safety precautions of our present atomic energy operations were indeed effective, they became preoccupied with pointing out the problems inherent in a greatly expanded atomic energy industry. There constantly recurs through the report the idea that all is well today but for the future let us be very careful indeed.

In summary, the report was totally reassuring as regards nuclear weapons testing, it did not attempt to face up to the problems of an atomic war, and finally it was preoccupied with the potential hazards inherent in a developing era of large scale atomic power.

Summary Report of the Committee on Genetic Effects

This Committee consisted of geneticists, one authority on radiation pathology, one authority on radiological physics and radiation hazard control, and a mathematician, Dr. Warren Weaver of the Rocksfeller Foundation, who chaired the group.

They considered the genetic effects against the background of present knowledge concerning radiation as a cause of mutations in micro-organisms, plants, insects, and mice, bearing in mind the tendency of modern civilization to conserve all human life whether perfect or imperfect. They call attention to the perhaps greater importance of mutations which are relatively inapparent such as defects in resistance to disease processes, decreased fertility and curtailed life span, and impaired physical and mental vigor. The more dramatic mutations, monsters, still births, and early developmental defects leading to abortion and miscarriage are not apt to be passed on to another generation. The apparently relatively negative results of the genetics survey of the survivors' first generation at Hiroshima and Nagasaki serve to emphasize the validity of this point of view. This study demonstrated that with the methods used and the radiation dosages received, the heavily irradiated surviving population was not sufficiently large for it to be possible to demonstrate a statistically significant difference in the number of mutations in the offsprings of irradiated parents as compared with offsprings of non-irradiated control parents. It did not prove in any sense of the word that there was no genetic effect.

NAS

Following a general discussion of the mechanisms of genetic change especially as produced by radiation, both natural and artificial, the committee made certain recommendations. In doing so they used natural background radiation exposure (i.e., radiation from cosmic rays, igneous rocks, radium and radiopotassium in our bodies, etc.) and the so-called spontaneous mutation rate as base lines. In addition they were unanimous that no increase in the spontaneous mutations rate was desirable and that all radiation exposure to the germ cells at whatever rate of exposure did indeed increase the mutation rate in proportion to the total exposure received at the time of conception. Consequently they stated that all radiation exposure to the gonads was detrimental and consequently radiation exposures should be kept at the minimum consistent with the overall needs of a society.

above

They then observed that half of the American children were born of parents approximately 30 years of age or less. They noted

that by the age of 30 the average American would receive germ cell exposures as follows:

1. Background or natural radioactivity	4.3r
2. Medical x-rays	3.r
3. Fallout from weapons testing if continued at rate for the past 5 years	0.1r (0.02 to 0.5r)

They then estimated that the exposure necessary to double the mutations rate in humans lay between 52 and 150r, more likely 30r to 80r, but also that different gene loci were quite different in their sensitivity to radiation. Taking these observations into consideration they felt that if the population as a whole were to receive no more than 10r man-made exposure to radiation to the germ cells prior to the age of thirty no serious consequences would result. They therefore, recommended that no one should receive a total accumulated dose to the reproduction cells of more than 50r prior to the age of thirty without clear cut medical reasons, and that in any event the average exposure of populations as a whole should not exceed 10r by the age of thirty. They point out that at present about 1/3 this figure is already being used up by medical x-ray exposures many of which could with proper precautions be greatly reduced.

As to occupational exposures the Committee considered this to be a limited group - no estimates were made as to its actual or potential size.

As finalized in the report the recommendations are:

1. There should be a national system of keeping radiation exposures on all persons as is now practiced at AEC establishments.

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2. Medical exposures to the germ cells should be reduced.

3. No more than 10r by age thirty for the population as a whole.

4. The subject should be reviewed periodically with a view to possible further reduction in exposure.

5. No body, however, employed, should receive more than 50r of exposure prior to the age of 30.

6. For special activities inherent in which are a greater liability to overexposure individuals who for one reason or other are unlikely to procreate should be selected.

7. The state of knowledge in the field of genetics has been outrun by our knowledge in the field of physics.

8. Keep all exposures to the germ cells as low as possible for radiation exposure is generally detrimental to living cells.

In essence, this Committee formalized the current thinking on the subject. It did not come up with any new or startling conclusions or recommendations.

The Committee on Pathologic Effects of Atomic Radiation

This Committee was composed of scientists well versed in radiation pathology and chaired by Dr. Shields Warren, Director of the Cancer Research Institute of the New England Deaconess Hospital, Boston, Massachusetts, and was for five years -- 1948 to 1952 -- Director of the Division of Biology and Medicine of the Atomic Energy Commission.

This group and subcommittees on blood, lung, delayed effects, and toxicity of ingested radioactive materials reviewed the present state of knowledge and found that our knowledge of immediate effects was much greater than for delayed effects. They observed a five year lessened life span for American radiologists, estimated to have received from a few roentgens to 1000r of exposure as compared with physicians not using radiation -- and agreed that until we had more precise knowledge of the cumulative effects of repeated small exposure of the whole body to radiation the rule of thumb recommended by the Genetics Committee could equally well apply to medical effects. That is, no one should receive more than 50r total accumulated dose to the reproductive cells by age 30 - and no more than 50r for each decade thereafter. This, they felt, would assure that any life expectancy curtailment would be exceedingly minor, and the likelihood of induced leukemia minimal. They noted that as far as effects on the blood-forming organs, the intestinal tract, etc., are concerned, none of these effects have been detected among those who have adhered to present permissible dose levels. NAS

As for the hazards from ingestion and radioactive materials, they confirmed the validity of existing National Committee for Radiation Protection and International Commission for Radiation Protection recommendations and as for the most important of the fission products in fallout, namely Strontium-90, they stated "there seems to be no reason to hesitate to allow a universal human strontium burden of 1/10 of the permissible yielding 20 rep in a lifetime..... Visible changes in the skeleton have been reported

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only after hundreds of rep were accumulated and tumors only after 1500 or more." The permissible level referred to is that recommended by the NCRP for industrial workers. The Committee noted that although "some children have accumulated a measurable amount of radioactive strontium in their bodies, the amount is quite small--a thousandth of what is considered a permissible dose. The Committee concluded, "then, that Strontium-90 is not a current threat, but if there were any substantial increase in the rate of contamination in the atmosphere, it could become one."

Committee on Meteorological Aspects of Atomic Radiation
Chairman - Harry Wexler - U. S. Weather Bureau

In this part of the report there is the fullest discussion of fallout from nuclear weapons. They distinguish between kiloton bursts when the cloud does not penetrate to the stratosphere and megaton bursts where the cloud does. They estimate that with surface bursts, i.e., where the fireball touches the ground 70-80% of the residual radioactivity falls out nearby, i.e., with small weapons a few miles, with larger ones up to 300 miles or more. They emphasize the ease of predicting this "nearby" fallout pattern after the fact and the problem of predicting its precise pattern prior to detonation.

They speak of intermediate fallout, i.e., material of small particle size released below the stratosphere and some 80% of which falls out within three weeks in the same hemisphere in which it originated and tending to uneven distribution associated with rainfall and wind patterns along a broad band in the same general latitude as that of its origin. Finally, they refer to delayed fallout of material which has gained entry into the stratosphere. It is slow with an average storage time in the stratosphere of 10 years, plus or minus five years. AEC believes the latter figure - five years - is the more likely. This delayed fallout tends to distribute itself more or less uniformly over the surface of the earth over the years.

NAS

They state that "at present, the amount of Sr 90 in the stratosphere from nuclear weapons tests is far too small to approach maximum permissible concentration even if it were all deposited now." They urged a continuing program to check on the amount of radioactivity in the stratosphere as necessary so that if there were to be a greatly increased rate of thermonuclear weapons testing activities we would know at the earliest moment when it was time to slow down in terms of potential hazard from Sr 90 to man.

There is also a discussion of the radioactivity from fallout of the intermediate and delayed variety. They point out that it

is usually too feeble to measure with a hand monitor - that air sampling does not give precise results as the amount of the passing air does not bear a direct relationship to what falls on the ground. The best measures of the actual fallout available to date are laboratory analysis of fallout on gummed paper, in collecting pots, and actual analysis of the soil.

There is a discussion of atmospheric radiocontamination as a result of uncontrolled release of materials such as radiokrypton and radioiodine from power reactors and processing plants. They point out that continued control over release of these products as is now done is essential. Control is by permitting a "cooling" time for short-lived radioactive materials to decay away, by off-gas cleaning, and by scheduling release of materials with due regard to meteorological conditions at the time.

There is a section on possible uses of radioactive materials in the study of the science of meteorology. Natural radon gas in the air can be helpful in understanding vertical movements of air from the land. Weapons tests have taught much with respect to lateral spread of air masses at various altitudes - how rain scavenges the atmosphere of particles - the rate of transport from the stratosphere to the troposphere and the removal time for water from the atmosphere. Experiments could be conducted using introduced radioactive materials under controlled conditions to study air flow and diffusion rates, hydrometeorology, i.e., condensation, precipitation and evaporation, and to study electricity of the atmosphere especially the possible relationship of electrical fields to the weather.

As to effects of nuclear weapons testing on the weather the committee stated:

1. Nuclear Weapon debris was not effective as a seeder for rain.

2. The amount of ionization produced is insignificant in meteorological terms.

NAS

3. There has been no measurable decrease in the amount of direct sunlight reaching the earth whereas volcanoes have known to decrease it by as much as 10-20% for appreciable periods of time.

4. The apparent recent increase in severe storms is probably the result of "improved methods of reporting."

Committee on the Effects of Atomic Radiation, Oceanography and Fisheries - Chairman, Roger Revelle, Scripps Institute of Oceanography

This group viewed the past record of this country with respect to pollution of streams, waterways and harbors with extreme repugnance. They point out that 71% of the earth's surface is ocean and that eventually everything gets into the oceans.

They note that the sea as compared to the land is relatively non-radioactive. Natural radioactivity of the seas is 1/100 that of igneous rocks. As a result of weapons tests they report the following: two days after Operation Castle was over in the spring of 1954 there was a millionfold increase in radioactivity of the surface waters near Bikini; that after four months 1500 miles away it was three times the normal amount and that at 13 months the area of surface water contamination had spread over a million square miles, and that at a distance of 3500 miles from Bikini the "artificial" radioactivity was 1/5 the natural.

They concluded that to date there has probably been no damage to life in the sea except that at the test site proper. They call attention to concentration of radioactivity by plant forms in the sea and warn repeatedly against indiscriminate dumping of radioactive wastes into the sea. They discuss the "flushing time" of the Black Sea-2500 years as compared with perhaps 100 or 200 years for the shelf-deeps of the Atlantic and Caribbean. They stress they need to know much more about the ocean depths and their movements. (The International Geophysical Year has a very large-scale study of the depths planned for 1957-58). This committee would apparently permit "controlled" sea disposal especially of short-lived radioactive materials. They recommend that "Industrial agencies formulate conventions for the safe disposal of atomic wastes at sea, based on existing knowledge." This would seem to be a very logical and necessary move. To date, except for small amounts of short-lived material, the U.S. has not dumped any radioactive wastes in the sea. We are still storing all process wastes in tanks.

NAS

They further recommend collaborative studies of the oceans and their organisms and though a beginning has been made urge a greater effort. Finally, they contend that in ten or twenty years certain radiotracer experiments will not be possible because of widespread low level contamination of the seas. This may well be true.

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Committee on the Effects of Atomic Radiation on Agriculture and Food Supplies - Chairman, Prof. A. G. Norman, University of Michigan, Ann Arbor, Michigan

This group first discussed the application of atomic energy techniques to the agricultural sciences. They feel great advances will be forthcoming, but perhaps not as soon as some claim. They note the value of radioactive tracer studies in improving our knowledge of how most economically to apply fertilizers, and to improve plant nutrition. They note the great potential value of ionizing radiation to induce mutations in speeding up crop improvement programs. They point up the invaluable contribution tracer studies can make to our understanding of animal nutrition. They touched on the problem of radioisotopes as possible contaminants in food products and point out that present law classes radioisotopes of any sort or in any amount as poisons. They urge a more realistic approach to this inasmuch as no food product is or ever has been literally free of radioactivity.

There is a general discussion of possible effects of fallout and the like on the ecology of the country. The committee recommends that it may well be in the public interest to expand the present programs to a continuous study of the changes in levels of background radiation and the movements of radioactivity in the system. (This is in essence an activity that the AEC has already underway and is expanding very much along the lines recommended.)

Finally, there is a statement concerning use of radiation for food processing. They note that relatively low exposures will destroy parasites in meat and inhibit sprouting in potatoes and onions. They also note that for sterilization extremely large doses are required (millions of roentgens). They felt this area of development was moving as rapidly as warranted and that the interest of the consumer will be adequately protected. They expect at a later date to review the evidence for wholesomeness and acceptability of irradiated foods. NAS

Committee on Disposal and Dispersal of Radioactive Wastes Chairman, Abel Wolman, Johns Hopkins University

This group considered the magnitude of the problem not as it is today but as it will become with full scale production of power by nuclear reactors. They note that to date essentially none of these wastes has been returned to the environment. It is being stored in tanks. They point out the importance of developing more economic methods of handling these wastes to the total development of atomic power. They have no quarrel with present practices but are concerned at the future magnitude of the problem.

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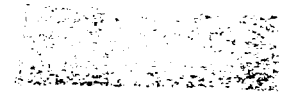
They estimate that by 1980 there will be 20 x 10^7 gallons of wastes to deal with. These must, they say, be contained in some form or other. AEC has a large program to cope with this problem on two fronts -- one, to produce perhaps by sintering a non-leachable stable mass and, two, to remove by separation the worst offenders, Sr^{90} and Cesium^{137}.

They note present practices with regard to radioisotope production, transportation and utilization are sound, but suggest review from time to time as their very rapidly expanding activity continues.

The discussion of reactor accidents as a hazard is quite general. They urge continued requirement of containment of the reactor itself for all but small research reactors as practiced today in this country. They urge constant vigilance and conclude that the extreme hazard -- total vaporization of a reactor -- is unlikely.

In other words, this entire study adds up to reassurance for the present, and repeated urgings to keep vigilant lest this new technology needlessly get out of hand.

NAS



Critique of British Medical Research Council
The Hazards to Man of Nuclear and Allied Radiation

A Report to the British Medical Research Council

The British Medical Research Council is a governmental body and was directed by the Prime Minister on 29 March 1955 to appoint a committee under the chairmanship of Sir Harold Himsworth to review the existing scientific evidence on the medical aspects of nuclear and allied radiations.

This report consists of eight chapters. The first four chapters deal with basic understandings of radiation and its biological effects, the fifth chapter with existing and foreseeable exposures due both to peacetime uses of atomic energy as well as to nuclear detonations in testing and in warfare, the sixth part with recommendations of permissable exposure and the seventh and eight parts with summaries and conclusions.

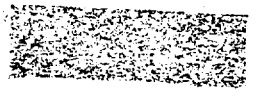
Chapter I is an introduction to the report.

Chapter II discusses in simple terms the nature of radiation and its action on living cells. It deals with well known units, methods of measurement and biological effects.

Chapter III discusses the effects of radiation on the health of the individual. It includes discussions of the early effects upon the Japanese at Hiroshima and Nagasaki and the later development of an increased incidence of leukemia among the survivors. The British state they have demonstrated an increased incidence of leukemia in patients with arthritis of the spine treated with x-rays. They cite also American statistics on the increased evidence of leukemia in radiologists. They conclude that radiations can induce leukemia but do not quantitate the exposure necessary for such an effect short of large single doses as at Hiroshima and Nagasaki. NAS

There follows a discussion of radiation as an inducer of cancer and a conjecture that 1000r exposure to radon gas and its daughter produces induced lung cancer in the Schneeberg and Joachimsthal mines. Paradoxically, they go on to say that there is no evidence that external x- or gamma rays can cause lung tumors in man.

There is a discussion of radiation as a cause of bone tumors drawn principally from the reports of cancer of bones in radium dial workers and individuals given radium therapeutically. Most of this is American data. They feel there is not much of a factor of safety



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in the present maximum permiss.ble concentration for radium. They indicate the risk of development of bone cancer from x-ray or gamma exposure in industry is insignificant. There is brief mention of skin cancer as induced by radiation, and thyroid gland cancer. Again the likelihood of this sort of thing from industrial exposure under modern controlled conditions is insignificant except, of course, in the event of accidental overexposure.

Radiation cataracts are mentioned as a hazard subject to ready control.

This report seems to understate effects of radiation on life span which has been so clearly proved in experiments with animals at, to be sure, radiation doeses somewhat above permissible levels. The National Academy of Sciences report emphasizes this effect and cites the reduced life expectancy of American radiologists.

Both reports mention effects of radiation on developing fetuses, and the temporary sterility in males exposed to a few hundred roentgens at a single exposure. The British report is totally reassuring on the effects of occupational exposures on fertility.

Chapter IV is a very lengthy genetics effects discussion with many figures, tables and calculations and a critique of the Atomic Bomb Casualty Commission genetics study in Japan. This is a highly technical discussion and comes out with the same conclusions as does the National Academy of Sciences, namely that a dose of radiation which would double the mutation rate of a relatively small group of prospective parents would produce no noticeable effects. "For levels of radiation up to the doubling dose, and even some way beyond, the genetics effects of radiation are only appreciable when reckoned over the population as a whole and need cause no alarm to the individual on his own account."

Chapter V discusses natural radioactivity -- radiation from appurtenances of civilization and occupational exposure to radiation. The report concludes that diagnostic medical x-rays produce exposures to the germ cells of the order of 22% that of background and constitute the most important source of man-made irradiation. It is estimated that the United Kingdom Atomic Energy Authority's employees receive an average does of 0.4r per year.

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The estimated external radiation exposure to people in Great Britain from fallout from all past nuclear tests has been quite minimal. "... Including all ordinary atomic bombs exploded before December 1955, and calculating all of the radioactivity which they have contributed and will contribute over the next 50 years, it is found that the total dose which a man, continuously out of doors, day and night, would receive is 0.005 r. To this dose from ordinary atomic bombs must be added the does of thermonuclear weapons. For these latter the dose from the radioactivity still to be deposited is

more important. It can be estimated that the accumulated dose from thermonuclear weapons is 0.002 to 0.003 r with another 0.027 r still to come. All these doses together add up to about 0.035 r from weapons already exploded. This is a maximum dose. The loss of radioactivity from weathering has not been taken into account, nor has the protection afforded by buildings in and around which most people in this country spend a large part of their lives. It would be realistic to divide the dose by three for weathering and by seven for protection afforded as a result of time spent in houses. The average inhabitant of this country may therefore receive in the next 50 years between 0.001 and 0.002 r from this fallout, or 0.02 to 0.04 per cent of the radiation that he will receive during the same period from natural surroundings."

The report has this to say about the effects of a continuing program of testing: "... if the firing of both types of bomb were to continue indefinitely at the same rate as over the past few years, there would be a build-up of activity gradually reaching a plateau in about a hundred years time which, on the same basis of calculation, would give the average individual a dose over a period of 30 years of 0.026 r or about 0.9 per cent of what he would receive in the same period from natural sources."

An important radioactive component of fallout material is Strontium 90. This isotope may be deposited in the bone and when present in sufficient quantities can cause bone cancer. The United Kingdom Medical Research Council report estimates that to date about 0.011 curies of Strontium 90 per square mile has fallen and that future deposits from past tests may produce a maximum of 0.045 curies of Strontium 90 per square mile by 1965. These data are immediately evaluated in the report, "... these figures should be viewed against the background of the fact that the top one foot of soil has always contained on the average about one curie per square mile of the equally, if not more, dangerous naturally occurring radium."

They estimate the hazard from plutonium in fallout as very small. They feel Cesium 137, Iodine 131 and Barium 140 are of very little significance outside a nearby area of very heavy contamination. They estimate the gonadal dose as 1% of natural background and diagnostic radiology as 22%. The discussion of atomic warfare is too scant to consider here.

NAS

Chapter VI, Assessment of the Hazards of Exposure to Radiation, is in essence a summary of the foregoing -- pointing out the differences between effects on the individual and genetic effects. They conjecture that no "authoritative recommendation will name a figure for permissible radiation dose to the whole population additional to that received from natural sources, which is more than twice that of the general value for natural background radiation." This is estimated by the British at 0.1 r per year, hence 3r in 30 years and 7r in 70 years. The National Academy of Sciences estimate is an average of

4.3r r in 30 years from natural background exposure and they recommend 10r as the top figure for average exposure of the population as a whole before age 30.

As to the hazard from strontium^{90} the report states "if the concentration in human bones showed signs of rising greatly beyond one-hundredth of that corresponding to the maximum permissible occupational level" they would feel that immediate consideration were required. This figure is 10 times the highest they report in man today. The National Academy of Sciences report states "It appears, then, that strontium^{90} is not a current threat, but if there were any substantial increase in the rate of contamination of the atmosphere, it could become one."

The conclusions are to all intents and purposes identical to those of the National Academy of Sciences report.

1. Adequate justification should be required for the employment of any source of ionizing radiation on however small a scale. This is not explicitly stated in the National Academy of Sciences report but is inherent in it.

2. Dose levels to the individual -- 0.3r per week -- 200 r in a lifetime for occupational exposures and no more than 50r the first thirty years of life.

3. No more than twice natural gackground from man-made sources for the population as a whole.

NAS

4. The present and foreseeable hazards from external radiation due to fallout at present rate of testing is insignificant. As to internal hazards from strontium^{90} at its present level no detectable increase in the incidence of ill-effects is to be expected. "Nevertheless, recognizing all the inadequacy of our present knowledge, we cannot ignore the possibility, that if the rate of firing increases and particularly if greater numbers of thermonuclear weapons are used, we could within the lifetime of some now living, be approaching levels at which ill effects might be produced in a small number of the population." This is a rather roundabout way of saying, "let's be careful."

5. a. All sources of radiation should be under close inspection. A personal record not only of doses of radiation received during occupation but also of exposures from all other sources such as medical diagnostic radiology should be kept for all persons whose occupation exposes them to additional sources of radiation. The National Academy of Sciences report would seem to include the whole population in its similar recommendations.

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b. Present practices in medical diagnostic radiology should be reviewed with the object of clarifying the indications for different special types of examination now being carried out and defining more closely, both in relation to the patient and to the operators, the conditions which should be observed in their performance. This says, in effect, "let's tighten up on unnecessary exposures."

c. The uses of radiotherapy in non-malignant conditions should be critically examined -- again, a warning to tighten up on unnecessary exposures.

d. The small amounts of irradiation from miscellaneous sources, such as x-ray machines used for shoe fitting, luminous watches and clocks, and television apparatus should be reduced as far as possible.

6. They end with a plea for better vital statistics. No comparable recommendation appears in the National Academy of Sciences report.

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