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U.S. ATOMIC ENERGY COMMISSION

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IV - BIOLOGY AND MEDICINE

Tolerance of Radiation by Active Troops

An ad hoc panel of radiologists and physicians met December 8, 1950, for the purpose of studying the amount of radioactive materials that military personnel could tolerate and still effectively carry out their assigned duties and missions in the Armed Forces. The panel consisted of Drs. Alan Gregg (chairman of the meeting), Austin M. Brues, Simeon T. Cantril, Andrew H. Dowdy, Louis H. Hempelmann, Robert F. Loeb, Curt Stern, Shields Warren; Brig. Gen. James P. Cooney for the Army; Admiral Thomas C. Anderson and Dr. Robert Flinn for the National Security Resources Board; and Major Gerritt L. Hekhuis for the Air Force.

In arriving at the conclusions the committee took into account the results of extensive animal experiments, the response of patients treated for disease by X ray and radium, observations on the effect of radiations from the atom bomb detonated over the Japanese cities of Hiroshima and Nagasaki and accidental radiation exposures within the Manhattan Project and the AEC.

Members of the Division of Biology and Medicine acted as staff to this committee in collecting and summarizing pertinent available research data and clinical information and presenting it to the committee for consideration.

The following questions were propounded and the answers are set forth as determined by the committee:

Question 1. Assume that troops are acutely exposed to penetrating ionizing radiation (gamma rays). At what dosage level will they become ineffective as troops?

Answer. Uniform dosage of 50r to a group of Armed Force personnel will not appreciably affect their efficiency as a fighting unit.

Uniform acute dosage of 100r will produce in occasional individuals nausea and vomiting, but not to an extent that will render Armed Forces personnel at any time ineffective as fighting units. Troops receiving an acute radiation dose of 100r and above ought to be given, as soon as feasible (within a week, if possible), a period for rest and individual evaluation.

Uniform acute dosage approximately 150r or greater can be expected rapidly (in a few hours) to render Armed Forces personnel as a group ineffective as troops through a substantial incidence of nausea, vomiting, weakness, and prostration. Mortality produced by an acute dose of 150r will be very low and eventual recovery of physical fitness usually may be expected.

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Field officers should therefore assume that if substantial numbers of their men receive acute radiation doses substantially above 100r, there is grave risk that their commands will rapidly become ineffective as fighting units.

Question 2. What dosage will render an air crew inefficient, that is, unable to complete a mission, during a flight of one to three hours, four to 12 hours, 12 to 48 hours?

Answer. In all three cases if radiation dosage to flight crew members is held below 75r, radiation exposure will be unimportant in determining the success or failure of a mission provided the crew members had not previously received an appreciable amount of radiation. In all three cases radiation doses substantially above 75r, combined with human stresses associated with military aviation missions in wartime, are considered to very seriously reduce the odds for successful completion of a mission.

Question 3. How often may an aircraft crew accept an exposure of 25r per mission and still be a reasonable risk for subsequent missions?

Answer. It is probable that at least 8 missions can be carried out at weekly or longer intervals, with exposure of 25r per mission, before the chance of mission failure becomes large due either to illness during the mission or significant general deterioration in health and ability. More missions may be feasible, but personnel should be carefully checked and evaluated before each mission and particularly before a decision to permit greater exposure than 200r total in these divided doses is made.

The possibility should not be ignored that cumulative radiation doses to the entire body above 200r may substantially reduce the life expectancy of the irradiated individual.

Question 4. A submarine crew is receiving 25r per mission. How many missions should it be allowed to make?

Answer. The answer is substantially the same as to Question 3. It is probable that at least eight missions can be carried out. Personnel ought to be carefully checked and evaluated after each mission. The possibility of substantial reduction in life expectancy by radiation doses totaling over 200r should not be ignored.

Biology Branch

Human genetics. At the November meeting of the Biology and Medicine Advisory Committee the question of supporting work in human genetics was discussed. In compliance with the general tenor of the discussion, a proposal for investigation of certain human mutation rates was invited from Dr. James V. Neel of the University of Michigan who had discussed this problem on several previous occasions with Dr. Zelle. Dr. Neel's proposal will be discussed at the January meeting of the Advisory Committee

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and will be the first research contract in human genetics if it is approved. This work will not deal with the effect of irradiation but only with naturally occurring mutations in man.

Longevity studies. Some of the mice surviving Operation Greenhouse are to be returned to the United States for observations over the rest of their life span. This work will be done in the Biology Division at ORNL. The Biology Branch was represented by Dr. Zelle at the December 18 conference at Oak Ridge to discuss specific plans for the cataract, tumor incidence, and longevity studies of these mice. The overall size of the study was reduced, a better statistical design developed especially for the control mice, and a convenient system of recording data on one IBM card outlined at the conference. Personnel requirements, financing, and other problems pertaining to the program were discussed.

The studies on the longevity of the mice from Greenhouse comprise only one part of a program on the effects of radiation on longevity. Other studies using external sources of radiation will be initiated with dogs and other species. Animals will be exposed to single X-ray treatments at various dosage levels, and also to intermittent exposures.

Irradiation effects on plants. Research at the U. S. Department of Agriculture at Beltsville on an AEC project has dealt extensively with the effect of radioactive isotopes on plant growth. In measuring the immediate effect of irradiation on plants it has been possible to measure a decrease in root length, in top growth, and the size of new leaves. These methods are only qualitative and with them little visible injury to plants is noticeable in such plants as barley and alfalfa when the plants are grown in nutrient solutions containing less than 50 microcuries of P^{32} per liter.

It has recently been observed that cell division ceases in the meristematic region such as the root tip or stem tip when subjected to a constant relatively high level of irradiation. The cells of the growing points enlarge; the cytoplasm in the cells become less dense; the cell walls thicken. In short, the region takes on a somewhat abnormally mature appearance. The other growing regions of stems and roots are similarly affected by radiation. However, the cell's apical meristems appear to be damaged when the plants are grown in solutions whose specific activity level was low enough to afford normal development of the rest of the plant. By measuring the size of the peripheral apical meristematic cells under a microscope it has been possible to observe effects of irradiation from 50 microcuries of P^{32} per liter of nutrient solution down to less than 2 microcuries. This is a range of activity over which there is no apparent change in the size of the plant.

These results indicated that this method will serve as a quantitative measurement of the effect of irradiation on plants at relatively low activities. It has thus been possible to show that even at the lower radiation levels there is an effect on plant growth.

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Civil Defense Liaison Branch

Civil defense legislation. On December 8, at the request of the Subcommittee of the Senate Armed Services Committee on proposed civil defense legislation, the Director of the Division of Biology and Medicine testified on the pending bill. His statement has been circulated for the information of the Commission on AEC 171/15 dated December 18, 1950.

Subject to a request to the Chairman, AEC, by Representative Whittington, Chairman of the House Public Works Committee, the Director of Biology and Medicine and the Acting Chief, Civil Defense Liaison Branch, met with Dr. Whittington and Representative Dondero to discuss effects of atomic weapons relative to pending legislation for dispersal of Federal agencies.

Shelters for AEC facilities. Major AEC installations have been requested through the operating program divisions to furnish "flash" estimates of the costs involved in providing adequate shelters for their populations, assuming enemy air attacks with atomic as well as other types of weapons, and warning systems capable of transmitting signals of such attacks to the populations involved.

To assist in formulation of these estimates tentative design criteria for communal type shelters and rough sketches of suggested family-type shelters were furnished as guides.

Design criteria for Savannah River plant. The Acting Chief, Civil Defense Liaison Branch, spent a major portion of his time during the month working with representatives of the Division of Production, the Department of Defense, and the du Pont Company in determining design criteria for the new Savannah River plant.

Review of public shelter plans. The Commission has informed the NSRB that it will examine for safety factors, if subject to atomic bomb attack, the plans for the Boston Common underground garage and plans for one other dual-purpose structure as requested by the RFC and the NSRB.

Review of White House plans. Plans for construction proposed for the East Terrace of the White House have been reviewed, at the request of the Architect of the White House.

Federal Civil Defense Administration--NSRB briefing session. Arrangements were made by the Branch for a briefing session by FCDA and NSRB personnel with AEC staff members to discuss civil defense activities related to the three AEC communities. At the meeting the process of designation of so-called critical target areas throughout the country was explained and the factors determining such designation were outlined. State maps showing critical areas for the states containing the AEC communities and states adjacent thereto were provided and have been transmitted to the communities.

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Information furnished FCDA and NSRB. The Acting Deputy Administrator, FCDA, and the Director, Health Resources Office, NSRB, have been furnished a statement of levels of radioactive contamination in water and food permissible under emergency conditions. This statement was prepared for use of the AEC emergency radiation monitoring teams in event of atomic disaster and was furnished these agencies for use in their national civil defense program.

Review of FCDA documents. FCDA's "Health Services and Special Weapons Defense" Manual was further reviewed for technical accuracy in galley-proof and page-proof form prior to its public release on December 27, 1950.

Radiation Instruments Branch

The FCDA issued Specifications for Civil Defense Radiological Monitoring Instruments on December 6, 1950, as the result of initial broad specifications prepared by the Radiation Instruments Branch. Although there are several points in the issued specifications with which AEC persons are not in complete agreement, the specifications will be useful to radiation instrument manufacturers in giving them firm operational characteristics to which they can design instruments. It is proposed that resulting prototype instruments will be evaluated by the National Bureau of Standards.

Procurement and Industrial Development Activities

AEC-sponsored research and development. Twenty of the civil defense radiation monitors manufactured by the Victoreen Instrument Company under AEC contract were received during December. These instruments are of the ionization chamber type employing the DuBridge-Brown electrometer circuit. The upper range of these instruments is 25 roentgens per hour. No determination has been made of the spectral and performance characteristics of these instruments.

Inspection and testing. During the month of December, 180 radiation detection instruments, accessories, and components were received and tested. Seventy-five neutron dosimeters produced by the Cambridge Instrument Company were rejected because of manufacturing defects. Since these dosimeters were procured under a production development contract supervised by the NYO Instruments Branch, they will be returned to their laboratory for further inspection and return to the manufacturer.

Technical Coordination Activities

Military activities in radiation instrumentation. Progress reports concerning the many military administered contracts involving research in radiation detection have not received sufficient distribution within the AEC. Since it would be difficult to obtain the number of copies to make a complete distribution, the Branch is planning to abstract and disseminate this information directly. Initially, a Compendium will be

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distributed listing the activities and progress to date. Supplementary "news letters" will be sent out monthly.

Research Projects Approved during December, 1950

Medicine

Western Reserve University - $8,000 (1 year) - Dr. C. E. Carter - "The effects of ionizing radiation on the content and metabolic functions of ergothionine in hematopoietic tissue"

Columbia University - $15,000 (1 year) - Dr. Harry Grundfest - "Study of changes in permeability of normal, poisoned and irradiated nerve fibers"

University of Pittsburgh - $11,000 (1 year) - Dr. Marie A. Fischer - "Mechanism of protection against radiation"

Harvard University - $9,803 (renewal, 1 year) - Drs. David G. Cogan and R. D. Evans - "Production of cataracts by neutrons and other radiations"

University of North Carolina - $4,320 (renewal, 1 year) - Dr. J. C. Andrews and M. K. Berkut - "Tracer studies and irradiation in dental metabolism"

Tulane University, School of Medicine - $9,560 (1 year) - Dr. W. S. Wilde - "The metabolic exchange of tissue electrolyte"

Tulane University - $22,140 (1 year) - Dr. Roy H. Turner - "The influence of radiation injury upon physiology of serum lipids with particular reference to the function of the liver"

Biology

Iowa State College - $14,674 (1 year) - Dr. Samuel Aronoff - "Research on the metabolism and physiology of roots"

Iowa State College - $9,900 (renewal, 1 year) - Dr. R. R. Sealock - "The combined biochemical and physiological action of tyrosine and vitamin B-12"

Michigan State College - $8,700 (1 year) - Dr. H. B. Tukey - "The absorption and utilization of radionuclides applied to the leaves of plants"

The Emory W. Thurston Labs., Los Angeles, California - $6,000 (1 year) - Dr. Benjamin H. Ershoff - "Comparative effects of the known B vitamins and an unidentified antitoxic factor in liver on radiation injury in the rat"

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Biophysics

Washington University School of Medicine, Edward Mallinckrodt Institute of Radiology - Part I, Dr. Michel Ter-Pogossian - $11,582 (1 year) - "Measurement of clinical X-ray dosages and intensities by means of the use of scintillation media" - Part II, Dr. Wendell G. Scott - $20,304 (1 year) - "Scanning of *in vivo* concentrations in radioactivity in an attempt to locate metastatic tumors and internal malignancies in the human body"

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