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MANHATTAN DISTRICT HISTORY

BOOK I - GENERAL

VOLUME 7 - MEDICAL PROGRAM

SUPPLEMENT

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ATOMIC ENERGY ACT 1946

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FOREWORD

A Supplement to the Medical Program Volume of the Manhattan District History, referring to the period from 1 July 1946 to 31 December 1946, has been included in front of the original history in this volume.

In bringing this portion of the history up to date, there have been added two new Sections to the volume, covering the activities of the Medical Section in investigating the bombings of Hiroshima and Nagasaki and "Operations Crossroads".

The numbering and subjects for the Sections of this Supplement conform with those of the basic history, with the words "Supplement To" preceding each of the section numbers. The main paragraph numbers are in accordance with those of the original history and are preceded by the letter "S" with the exception of the main paragraphs in Sections 7 and 8. Subparagraphs, insofar as practicable, are designated in the sequence presented by the original history.

The information covered by this Supplement has not been included in the Summary of the Volume.

July 15, 1947

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ATOMIC ENERGY ACT 1946
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SUPPLEMENT

TO

MANHATTAN DISTRICT HISTORY

BOOK I - GENERAL

VOLUME 7 MEDICAL PROGRAM

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SUPPLEMENT

TO

MANHATTAN DISTRICT HISTORY

BOOK I - GENERAL

VOLUME 7 MEDICAL PROGRAM

SUPPLEMENT TO SECTION 1 - INTRODUCTION

There was no change in status in this section from that shown in basic history.

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[redacted] ATOMIC ENERGY ACT 1946

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SUPPLEMENT TO SECTION 2 - HAZARDS OF OPERATION

There was no change in status in this section from that shown in the basic history, except that the following paragraphs have been added to the Section:

S2-8. Hazards Due to Special Materials. - For brevity it is preferable to discuss the potential toxicity of special materials by first indicating the type of study to be carried out, followed by the presentation of these materials on which studies have been necessary.

a. Determination of the Toxicity. - An actual determination of the toxicity of a substance must be made indicating how poisonous it may be in both acute and chronic exposure. In this way the toxic levels may be avoided in laboratory and plant environments.

(1) The mode of entrance into the body by ingestion, inhalation and skin absorption must be studied as different manifestations and degrees of toxicity that may be produced by each route employed.

(2) A careful analysis must be made as to the character of the biological changes with the production of physiological, histopathological and biochemical evidences of damage incurred.

(3) The nature of these injuries and the mechanism by which they occur must likewise be studied inasmuch as this affords information as to the necessary protection and indicated therapy after exposure.

b. Preventative Measures.

(1) Effectiveness. - The effectiveness of physical methods for the removal of hazardous dusts, reduction in skin contact

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and prevention of ingestion must be measured, and methods for accurate determination of such hazards must be developed and used. The use of certain chemicals, ointments, and the like as protective measures must be studied as to their efficiency.

(2) Therapeutic Measures. - Appropriate investigation of therapeutic measures to be used in the treatment of both acute and chronic poisoning states should they occur in industrial exposure must be made.

Completion of all phases of the above program on a variety of substances provided complete information as to the medical aspects necessary to be considered in protection of the worker, prevention of injury and treatment of injury should it occur.

c. Substances. - Substances on which studies of this type are necessary are:

(1) Uranium and its compounds.

a. Uranium metal and its chemical compounds, oxide, nitrate, chloride, bromide, tetra and hexafluoride, sodium and ammonium sulfates.

b. Uranium chain of heavy metals.

Uranium X1

Uranium X2

Radium

Polonium

c. Fission products of cleavage of U-235 and plutonium.

d. Artificial isotopes of uranium - 232, 234, etc.

[redacted]

[redacted]

(2) Thorium and its chain.

(3) Plutonium.

(4) Special Accessory Materials.

a. Fluorocarbons
b. Fluorine
c. Beryllium
d. Others

S2-9. Production Hazards. - The results of studies made on the materials discussed above are applied for the prevention and control of industrial hazards arising in the large manufacturing areas where these materials are used in large amounts.

a. The Electromagnetic and Diffusion Methods. - In the Electromagnetic and Diffusion Methods for the isolation of uranium 235 the major hazards are from the uranium compounds, the concentration of uranium X1 and X2, and the special accessory materials and by-products formed in the process of manufacture.

b. Pile Method. - In the graphite pile where plutonium (239) is produced on a large scale, the hazards are from the alpha, beta and gamma rays, neutrons, the plutonium metal and its compounds, the various radioactive fission products resulting from the pile operation.

c. Isolation of Polonium. - The chemical isolation of polonium following its formation in the pile incorporates hazards from alpha radiation following absorption into the body.

d. Medical Aspects of Plant Programs. - Study of the medical aspects of plant programs aside from the determination of the effect of radiation and chemical toxicity, include additional information obtained from plant investigations as from:

[redacted]

[redacted]

(1) Clinical survey of all exposed personnel.

(2) Monitoring of hazards by special instruments and methods.

(3) Surveys of new types of graphite piles and production equipment.

S2-10. Hazards of Atomic Catastrophe in Production Areas.

a. Immediate Effects.

(1) Radiation. - The radiation occurring at the time of the explosion coupled with blast and heat causes biological effects which may differ from those occurring following other acute known effects from gamma and neutron radiation, and demand study.

(2) Blast. - The blast of atomic explosion is so intense that it may have totally different types of shock waves and recoil waves with other unique biological effects. These all should be investigated.

(3) Heat. - The intense burns from actinic type of radiation have not been studied. This also includes the combination effect of all three items in this group: blast, radiation and heat.

b. Delayed Effects.

(1) Protective Devices. - A study of methods of protection against the radioactivity deposited at the time of blast is necessary.

(2) Decontamination. - Methods of decontamination of soil must be worked out for cleaning up active areas.

[redacted]

[redacted]

(3) Investigative Equipment. - Special equipment must be developed and tested for use in investigating bombed areas.

(4) Study of Casualty Effects. - Field study of fission clouds, possible injury to water supply, soil and topographical features and human damage by population surveys are necessary.

(5) Study of Treatment. - A study of the treatment of all immediate effects such as radiation, heat and blast should be made.

c. Catastrophe Information. - Preparation of pertinent information in proper form for use by catastrophe units in production areas should be studied.

S2-11. Research Program 1946 - 1947. - With the termination of a large number of research problems the changes in the research allottments and a shifting of personnel back to their peacetime jobs it was also necessary for the directors of the various medical projects to shape up new research programs to meet all of these conditions. In addition, new problems requiring investigation followed modification of the research and production programs and it was deemed necessary to set up additional programs to speed the work, (beryllium and thorium toxicity being two of the major items). For convenience, and clarity it seems wise to list all the programs giving specific experiments by title. At this time no results can be given inasmuch as very few problems have been under investigation sufficiently long to produce positive results. This program was approved by the Medical Committee

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on December and can be listed as that recommended to the AEC for continuation.

S2-12. Types of Research Conducted, and Installations Conducting This Research within the District.

a. Argonne National Laboratories (University of Chicago)

(1) General physiological picture of acute and chronic radiation.

(2) Radiation effect on blood clotting, lymphocyte distribution and spread of infection.

(3) Toxic effects of external radiation and absorbed radioactivity.

(4) Response of blood cells to various types of radiation.

(5) Chronic effects of radiation and radioactive materials in animals.

(6) Mode of action of radiation in carcinogenesis.

(7) Chemical and physiological basis of radiation effects.

(8) Metabolism of radioactive elements.

(9) Instrument standardization, design, etc.

b. Radiation and Radiology Section (University of Rochester)

(1) Instrument design, measurement standardization, industrial monitoring.

(2) Biological effect of tracer amounts of polonium, radium and uranium in human and animal subjects. Application of tracer experiments to serve other parts of the project.

[redacted]

[redacted]

(3) Physiological effects of exposure to acute and chronic radiations including radio isotopes; search for therapeutic methods of value.

(4) Development of possible chemical technique or methods of detection of radiation damage and the mechanism by which such effects are produced.

(5) By means of spectroscopic methods to study distribution of uranium and other heavy metals of importance in animal tissue; search for possible clues as to the method of bony deposition of radioactive materials.

(6) Study of the time intensity factor in radiation and development of methods of producing instantaneous exposure to radiation (A bomb effect).

(7) Study of the metabolism of plutonium, polonium, radium, etc., in human subject.

c. Pharmacology Section (University of Rochester)

(1) Study of the inhalation toxicity of various uranium, beryllium and thorium compounds. Studies in the mechanism of production of inhalation toxicity.

(2) By chemical technique, studies of the mechanism of uranium fixation in bones, uranium complex function, methods of excretion of uranium.

(3) Toxicity of uranium, beryllium and thorium compounds by ingestion.

(4) Pathological effects of uranium, beryllium and

[redacted]

[redacted]

thorium poisoning and mechanism by which produced.

(5) Physiological effects of uranium, beryllium and thorium poisoning.

d. Experimental Surgery (University of Rochester)

(1) Clinical, hematological and pathological effects of acute lethal radiation.

(2) Methods of bone marrow transplantation.

(3) Studies in bone marrow reserve and radiation effect.

(4) Tissue culture studies related to bone marrow production.

(5) Effect of folic acid and rutin on marrow regeneration.

(6) Studies in metabolism of iodine by thyroid (15%).

e. Experimental Hematology. (University of Rochester)

(1) Comparative study of blood histamine and hematological effects in cells.

(2) Studies on life cycle of blood platelets.

(3) Studies on life cycle of WBC leukocytes.

(4) Studies on marrow reserves after radiation.

(5) Evaluation of coagulation defects following irradiation.

f. Genetics (University of Rochester)

(1) Continuation of studies of effect of chronic radiation on mice.

(2) Continuation of studies on effect of acute and chronic radiation (X-ray) on Drosophilia.

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[redacted]

g. University of California.

(1) Studies of the metabolism of plutonium, uranium and fission products in rats and man.

(2) Fission product tracer studies.

(3) Metabolism of radium, actinium, americium and curium in animals and man.

(4) Studies (pilot) on possibly hazardous artificially induced radioactive elements, i.e. chromium, nickel, etc.

(5) Beryllium tracer studies.

(6) Treatment of plutonium poisoning.

(7) Behavior of fission products in soils.

(8) Biological effects of fission recoils.

(9) Search for other U compounds which will localize in organs other than liver and spleen (15%).

(10) Biological effect of disintegration products of boron and lithium of the neutron irradiation (15%).

(11) Study of element 85 in the thyroid (15%).

(12) Training of Crossroads personnel.

(13) Studies in whole body radiation of human subjects.

(14) Studies on metabolism of radioactive iodine in animals and man.

h. Columbia University.

(1) Studies on the measurement of fast neutrons for biological dosage.

(2) Development of a method of measuring neutron dose by chemical means.

[redacted]

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(3) Measurement of radioactive isotopes for biological and medical application.

(4) Correlation of tissue doses and biological effects produced by external irradiation and by radioactive isotopes internally administered.

(5) Exploratory biological experiments to extend use of radio-active isotopes as tracers on therapeutic agents (15%).

(6) Studies of the fundamental biological action of ionizing radiation.

(7) Measurement of the radiation of radioactive isotopes to provide data for the protection of personnel and films in transit.

i. University of Washington (Seattle)

(1) Acute and chronic effects of external radiation on fishes.

(2) Breeding studies on salmon following radiation.

(3) Studies on the effects of Hanford effluent on salmon and trout.

(4) Effect of internally deposited radioactive materials on fishes.

(5) Field studies on the effect of possible Hanford pollution on fish life of the Columbia River.

(6) Plankton experiments - effect of radiation on higher forms (new).

(7) Feeding experiment on deposited radioactive materials (new).

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j. Monsanto Chemical Corporation (Clinton Laboratories) United States Public Health Service.

(1) Continuation of studies on the biological effect of slow, fast and thermal neutrons on rats and mice.

(2) Continuation of studies on the comparative biological effect of penetrating radiation.

(3) The effect of internally deposited plutonium on bone healing.

(4) Cytological program on the biological effect of radiation on simple cells and tissue.

(5) Instrumentation and techniques of radiation monitoring.

k. Monsanto Chemical Co. (Dayton) New program being organized.

(1) Biological effects following chronic exposure of animals to polonium by inhalation and parenteral administration.

(2) Correlation between chronic exposure of workers and polonium excretion rate.

(3) Mechanism of action of polonium toxicity.

(4) Development of special health physics technique for specific use in polonium purification.

l. Los Alamos.

(1) Fundamental studies on the effect of acute radiation exposure.

(2) Treatment of acute radiation disease.

[redacted]

[redacted]

(3) Methods of detecting early radiation changes.

(4) Metabolism of plutonium, U-235 and other radioactive materials.

(5) Detection of accumulated plutonium in the lungs.

(6) Biochemical studies of nucleoproteins and the effect of radiation on the fundamental physiology of the cell.

(7) Detailed study of absorption of plutonium from contaminated wounds.

(8) Any special problems arising from medical hazards peculiar to this project.

m. Western Reserve University.

(1) Investigation of the toxic effects of thorium and its isotopes.

(2) Comparative studies on the biological effect of external radiation and from internally deposited radioactive materials.

(3) Use of radioactive isotopes in fundamental biological research.

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SUPPLEMENT TO SECTION 3 - INDUSTRIAL MEDICINE

S3-1. There was no change in status in this paragraph from that shown in basic history.

S3-2. There was no change in status in this paragraph from that shown in basic history.

S3-3. There was no change in status in this paragraph from that shown in basic history.

S3-4. There was no change in status in this paragraph from that shown in basic history.

S3-5. There was no change in status in this paragraph from that shown in basic history.

S3-6. Organization. - The research branch of the Medical Division has continued under the supervision of Major J. W. Howland working closely with the Advisory Group under Col. S. L. Warren (now Dr. S. L. Warren) following his return from Operations Crossroads where he acted as Chief of the Radiological Safety Section. Lt. R. V. Randall replaced Capt. D. Goldring, AUS who was discharged in July 1946. Several changes have occurred involving changes in directorship of the Research Groups, however. In July 1946 Dr. A. M. Brues succeeded Dr. L. Jacobson as head of the Medical Group of the newly formed Argonne National Laboratory which supplanted the previous Metallurgical Group of the University of Chicago. Dr. Paul Henshaw acted as head of the Clinton Laboratory Medical Group under the Monsanto Chemical Company for a short time, until an agreement was made between the United States Public Health Service and the Monsanto Group in October 1946. Stating that Dr. A. Hollandaer

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was appointed director and Dr. Henshaw placed in charge of the radiation studies already being investigated. With the change in supervision, a definite modification of program at the Clinton Laboratories is taking place. New medical research programs have been instituted at the Monsanto Chemical Company at Dayton under the direction of Dr. Joseph Svirbely and at the Western Reserve University at Cleveland under Dr. H. L. Friedell. The Dayton program relates to further investigations of the polonium problem. The Western Reserve program is investigating thorium toxicity and certain special aspects on the fundamental nature of biological action of radiation. New contracts have been approved for workers at the University of California at Berkeley. Dr. R.S. Stone, formerly medical supervisor of the Metallurgical Project, has assumed directorship of the program on whole body radiation in human and biological effect of radioactive iodine. Dr. John H. Lawrence is working on certain fundamental aspects of radio isotope research. Dr. Lauren Donaldson of the University of Washington has expanded his program to meet certain findings pertinent to the project welfare and re-emphasized as a result of the Cross Roads Operation. His program now includes experiments both at the Hanford Engineering Works Project and at the Seattle Laboratories of the University of Washington. Finally, two new programs have been submitted by the University of Virginia under Dr. Alfred Chanutin specializing in protein chemistry, and by the University of Tennessee under Dr. Henry Wills specializing in kidney physiology. Both of these were approved by the medical advisory committee in December 1946 but have not as yet been given formal approval of the District Engineer.

[redacted]

[redacted]

S3-7. Uranium Processing and Special Chemicals. - There was no change in status in this paragraph from that shown in basic history.

S3-8. Process Research. - There was no change in status in this paragraph from that shown in basic history.

S3-9. Process Equipment. - There was no change in status in this paragraph from that shown in basic history.

S3-10. Gas Diffusion and Thermal Diffusion Processes. - There was no change in status in this paragraph from that shown in basic history.

S3-11. Electromagnetic Process. - There was no change in status in this paragraph from that shown in basic history.

S3-12. The Pile Process. - There was no change in status in this paragraph from that shown in basic history.

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SUPPLEMENT TO SECTION 4 - CLINICAL MEDICINE AND DENTISTRY

S4-1. General. - There was no change in status in this paragraph from that shown in basic history.

S4-2. Clinical Medicine & Dentistry at Oak Ridge. - There was no change in status in subparagraphs a(1), a(2), a(3), from that shown in the basic history.

(4) Prepayment Plan for Medical Care.

(a) Modification to Prepayment Plan. - On 1 August 1946 the Oak Ridge Health Association ceased to function as the carrier for the prepayment plan covering hospital expenses. On 1 August 1946 the Provident Life Insurance Co. of Chattanooga, Tennessee, became the carrier for the group insurance plan. The Oak Ridge Health Association continued as a non-profit organization but acting as agent for the Provident Life and Accident Insurance Company.

(b) Cost to Subscriber. - The premium for individual subscribers was reduced to $1.75 per month. The charge of $4.00 per month for a family membership remained unchanged.

(c) Hospital Benefits. - The subscriber became entitled to reimbursement of expenses for services rendered to members of the subscribers family as bed patients in amounts equal to the sums allowed to the subscriber. The subscriber became entitled to physicians fees for medical attendance in non-operative cases at a rate of $3.00 per day for the duration of the subscribers hospitalization.

(5) Emergency Disaster Program. - There was no change in status in this subparagraph from that shown in basic history.

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a(6) Organization. - Army Medical Corps physicians assigned to duty at the Oak Ridge Hospital continued to be released from military service according to policies of the Surgeon General's Office. Most of these Medical officers, upon termination of their military service, remained on the staff of the Oak Ridge Hospital and continued Medical practice as civilian physicians, with the result that neither the total number of practicing physicians nor the service of an individual physician to the residents of Oak Ridge was appreciably affected.

A(7) Statistics. - Statistics from 1 July 1946 to 31 December 1946 inclusive.

1946	Doctors* M	C	T	Nurses	Attendants	Orderlies	Out patient**	Hospital Patient Days
July	9	18	27	121	39	19	2820	6740
Aug	9	19	28	113	43	18	2976	6809
Sept	9	19	28	115	45	19	2212	5875
Oct	6	22	28	115	45	19	1048	6068
Nov	6	22	28	120	46	18	781	6725
Dec	4	24	28	117	46	19	525	6126

*M - Military

C - Civilian

T - Total

**Represents only patients attended by Army Medical Corps.

b. The Dental Program. - There was no change in status in this paragraph from that shown in the basic history.

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c. Public Health Program. - On 22 July 1946 Dr. Charles H. Benning was appointed director of Public Health on the same date Mr. Leon S. Blankenship assumed the position of Chief of Public Health Engineering.

d. Veterinary Service. - There was no change in status in this paragraph from that shown in basic history.

e. The Cost. - The expense entailed in operation of the medical and allied facilities at Oak Ridge from 1 July 1946 to 31 December 1946 is indicated below:

Medicine	
Operating expenses	$662,074
Operating revenue	383,001
Operating deficit	$279,073
Dentistry	$4,930
Operating expenses*	
Public Health	
Operating expenses	$53,980
Veterinary Service	~~6,812~~
Operating expenses	5,812
Total Net operating cost of Clinical Medicine, Dentistry, Public Health and Veterinary Service at Oak Ridge from 1 July 1946 to 31 December 1946 inclusive.	$343,795

*Represents cost of supplies and salaries of Civilian personnel employed in the Military Dental Clinic.

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S4-3. Clinical Medicine & Dentistry at Hanford Engineer Works.

a. Construction Phase. - There was no change in status in this subparagraph from that shown in basic history.

b. Operations Phase. - There was no change in status in subparagraphs b(1), b(1)(a), b(1)(b), b(1)(c), b(1)(d) from that shown in basic history.

(c) Statistics. - From 1 July 1946 to 1 January 1947, the Medical Operating Statistics of the Kadlec Hospital, Richland, Washington, were as follows:

1946	Doctors*	Nurses*	Orderlies, Aides, etc.	Out-patient Treatment	Hospital Patient Dispensary	Total Population
July	18	93	38	3421	1565	12737
Aug	18	94	35	4846	2070	12631
Sept	15	94	36	3594	1831	12737
Oct	17	97	36	3437	2031	13253
Nov	18	93	36	3749	1897	13567
Dec	19	92	38	3839	2211	13396

* Numbers include personnel employed in industrial medicine.

(2) Dental Program. - The following table presents the Dental Clinic Statistics for the period 1 July 1946 until 1 January 1947:

1946	Dentists	Number of Dental Patients
July	5	1360
Aug	5	1483
Sept	5	1186
Oct	3	1090
Nov	8	1136
Dec	8	1218

[redacted]

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(3) Public Health Program. - There was no change in status in this subparagraph from that shown in basic history.

(4) Emergency Disaster Program. - There was no change in status in this subparagraph from that shown in basic history.

(5) The Cost. - Following is an estimate of the cost of providing Medical and related facilities and care for Richland Village from 1 July 1946 until 1 January 1947:

Permanent Medical Facilities additional Construction	None
Operating Cost	$331,676.97
Revenue	225,755.11
Total Net Medical Cost	$105,921.86

c. Breakdown of Operating Medical Costs and Revenue.

	Gross Expense	Non Industrial Revenue	Net
Dental Dept.	$23,677.72	$25,765.68	$ 2,087.96
Pharmacy	14,086.84	24,612.73	10,525.89
Utilities Heat, Water, Electricity, etc.	16,063.30		
Public Health	21,096.89		
Medical & Hospital Expense	256,752.22	175,376.70	21,096.89 81,375.52
Total	$331,676.97	$225,755.11	$89,858.56

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detection, and solvent detection.

3. Industrial Medicine. - The Division of Industrial Medicine of the District Medical Section was formed to aid Manhattan District contractors in establishing programs of industrial hygiene appropriate for the peculiar hazards encountered. The scope of activities varied, depending upon type of process used and types of hazards present. An industrial hygiene laboratory was instituted at the University of Rochester to perform special and unusual analysis necessary to control the various occupational hazards. Close liaison was maintained with other health-physics groups such as Metallurgical Laboratory at the University of Chicago, Clinton Laboratories, etc.; and also with the New York Safety Committee, a committee formed by engineers of the Kellex Corporation assisted by a medical officer from the Industrial Division. The Industrial Medical Division was originally under the supervision of Lt. Col. H. L. Friedell but in May 1943 this responsibility was transferred to Major John L. Ferry.

Uranium processing and its hazards were concerns of the Industrial Medical Division. Uranium was extracted from the crude ore and worked into various compounds such as black oxide, brown oxide, green salt (UF_4), hexafluoride (UF_6), and uranium metal. Process hazards, such as radiation exposure and chemical burns, were minimized by normal industrial safe practices or, where necessary, by special methods or protective devices. Inspections were made as frequently as necessary to insure the safety of the employees at the various contractors' plants.

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SUPPLEMENT TO SECTION 5 - BIOLOGIC AND HEALTH PHYSICS RESEARCH

S5-1. General.

a. Activities of the Medical Research Group. - During the period from 1 July 1946 to 1 ~~June~~ January 1947, the activities of the Medical Research Groups of the Manhattan District included the following:

(1) Termination of the research problems of the period 1942-1946.

(2) Writing of final reports and chapters for the medical volumes of the Manhattan Project Technical Series.

(3) Reorganization of the research projects in many instances under new research directors, and the setting up of new programs directly applicable to the peace-time application of atomic energy.

b. Aid in the Correlation of the Research Program. - To aid in the overall correlation of the research program, an interim medical advisory committee under the direction of Dr. S. L. Warren (formerly Col. S. L. Warren) was set up at the request of the District Engineer. Action of this committee toward the shaping of present policy and program as well as future recommendations are discussed in greater detail in Paragraph 2-6 and 2-7.

c. Report of Past Activities. - As mentioned above, a very major effort during this period was in the termination of research problems and the writing of reports, both as final reports and portions of the Manhattan Project Technical Series soon to be released. In a program of such a size, even the summarized accounts are of such magnitude that it becomes impossible to summarize them in any brevity. During this

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six-month period the research branch of the Medical Division has prepared a medical research summary of some 160 pages containing all the pertinent findings of all associated projects.

In the early part of this period it was requested by the District Engineer that the Research Division prepare for future use a formal statement of the general scope of the entire research project which would cover all past and future activities. This was modified from previously prepared material and was approved by the medical advisory committee at their September meeting.

S5-2. Purpose of Research Program. - There was no change in this paragraph from that shown in basic history.

S5-3. Radiation Research. -

a. General. - The radiations encountered in nuclear fission as well as those encountered from naturally radioactive substances divide themselves into the following types: Alpha rays, beta rays, gamma rays and neutrons. Information available from the literature on previous studies indicates a rather extensive knowledge of the biological effects of X-rays and gamma rays and very little information on alpha and beta rays and neutrons. The programs were and are organized along the following basic outline.

There was no change in subparagraphs b, c, d, e, f, and g from that shown in basic history.

h. The Physical Measurement of Radiation of Various Types. - In the physical measurement of radiation of various types, it is necessary to develop methods of accurately measuring and standardizing the

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dosage of radiation to be used in the biological experimentation and measurement of the extent of any hazardous radiation which might be found in a plant area.

i. The Biologic Effects of Radiation. - Because of the known deleterious effect of radiation on the animal organism, it becomes necessary to determine the effect of controlled dosages of the various types of radiation on various animal species, so that such observations can be used in the control of possible human exposure.

The types of biological effect possible to study are:

(1) The Survival Time or percentage that the effect of a given dose will reduce the normal life span of different animal species.

(2) The Genetic Effects of radiation as manifested in the development of abnormal individual types from changes in the hereditary mechanism.

(3) Histopathological changes as demonstrated by abnormal changes in the makeup of the various body tissues.

(4) Physiological changes produced by the alteration of the normal functioning of animal tissues following radiation.

(5) Biochemical and Enzymatic disturbances which are the potential source of these physiological abnormalities.

j. Methods for the Detection of Minimal Radiation Damage are developed directly from observation of the above types and are applied to the study of the human individual or worker. These include studies on:

(1) Biochemical and Enzymatic Changes which may be

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detected and which, if measurable, can be corrected before irreversible damage has taken place. Examples of such change would be effects on the metabolism of coproporphyrins, excretion of abnormal substances in the urine and the like.

(2) It has been known that radiation depresses the function of the hematopoetic system and detailed study is indicated to detect early changes under controlled dose radiation with all blood elements under continuous observation.

(3) The Production of Anatomical Changes such as epilation, skin erythema, and alterations in the integrity of the skin and the like must likewise be studied under controlled dosage.

k. Studies on Methods for the Prevention of Radiation Injuries. - Studies are likewise indicated on methods for the prevention of radiation injuries. These include:

(1) Methods of physical detection of external radiation by the development of sensitive direct reading instruments capable of the detection of amounts of radiation well below those necessary for demonstrable injury to the animal subjects.

(2) Methods for the determination of harmful amounts of radioactive dusts and gases in air, in water and the like. Many radioactive materials like radium are deposited in the body and in such locations produce injury to tissue. Methods based on the determination of dangerous amounts of these substances by examination of the excreta and direct measurements of the body itself are necessary.

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l. Protective Measures. - Studies on the efficiency of shielding against radioactive materials, the efficiency of exhaust and ventilating systems against dangerous amounts of dusts, the development of protective clothing and devices, and the development of remote control processing methods have been extremely important in the Manhattan District protection program to date and will continue into the future.

m. Therapeusis of Radiation Damage. - The possible therapeusis of radiation damage by the use of replacement therapy for the damaged bodily elements, as well as the reduction in the exposure following deposition of radioactive materials in the body deserves considerable study. Replacement of the damaged hematopoetic elements destroyed by severe radiation exposure offers one possibility; detection and neutralization of unknown toxic substances produced by radiation and other such difficult problems deserve consistent and detailed study.

All the above studies are necessary on alpha, beta and gamma rays and neutrons of varying intensity. In addition, the radiation from the radioactive substances to be discussed has likewise to be considered. Also, the effects of acute and chronic exposure must be determined because of their dissimilarity.

S5-4. Radioactive Substances - Hazard Research. - There was no change in status in this paragraph from that shown in basic history.

S5-5. Substances of Potential Chemical Toxicity. - There was no change in status in this paragraph from that shown in basic history.

S5-6. Industrial Research.

a. General. - There was no change in status in this paragraph from that shown in basic history.

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b. Contracts Awaiting Approval.

(1) University of Virginia. - Dr. Alfred Chanutin

Study of the effects of various types of radiation (alpha, beta, gamma and neutrons) on the circulating blood proteins by electrophorosis and protein fractionization technique. To determine whether means of early detection of radiation damage can be accomplished in this way.

(2) University of Tennessee. - Dr. Henry Wills

Study of the mechanism of toxic effects of uranium and other heavy metal compounds on the kidney. This is a continuation of Dr. Wills' work with the Rochester Manhattan Project during the war and contributes to that general study.

S5-7. Reports on Research Activities. - There was no change in status in this paragraph from that shown in basic history.

S5-8. Organization. - There was no change in status in this paragraph from that shown in basic history.

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SUPPLEMENT TO SECTION 6 - ORGANIZATION

There was no change in status in this Section from that shown in the basic history.

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SECTION 7 - HISTORY OF MEDICAL SECTION PARTICIPATION IN THE MANHATTAN PROJECT ATOMIC BOMB INVESTIGATION (1st TECHNICAL SERVICE DETACHMENT - INVESTIGATING THE BOMBINGS OF HIROSHIMA AND NAGASAKI).

7-1. General. - On 11 August 1945, two days after the bombing of Nagasaki, a message was dispatched from Major General Leslie R. Groves to Brigadier General Thomas F. Farrell, who was his deputy in atomic bomb work and who was representing him in operations in the Pacific, directing him to organize a special Manhattan Project Atomic Bomb Investigating Group.

This group was to secure scientific, technical, and medical intelligence in the atomic bomb field from within Japan as soon as possible after the cessation of hostilities. The mission was to consist of three groups:

a. Group for Hiroshima

b. Group for Nagasaki

c. Group to secure information concerning general Japanese activities in the field of atomic bombs.

The first two groups were organized to accompany the first American troops into Hiroshima and Nagasaki.

7-2. Purposes of the Mission. - The primary purposes of the mission were as follows, in order of importance:

a. To make certain that no unusual hazards were present in the bombed cities;

b. To secure all possible information concerning the effects of the bombs, both usual and unusual, and particularly with regard to radioactive effects, if any, on the targets or elsewhere.

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General Groves further stated that all available specialist personnel and instruments would be sent from the United States, and that the Supreme Allied Commander in the Pacific would be informed about the organization of the mission.

7-3. Investigating Group. - On the same day, 11 August, Colonel S. L. Warren, Chief of the Medical Section, was directed to select the special personnel to form the part of the investigating group to be sent from the United States. This group was ordered to California with instructions to proceed overseas at once to accomplish the purpose set forth in the message to General Farrell. In the two days between 11 August and 13 August, the personnel and equipment necessary to perform the mission were brought together.

7-4. Personnel. - The group from the United States, under the command of Colonel S. L. Warren, consisted of members of the Manhattan Project stationed at several of the continental installations.

7-5. Field Activities. - This group with their equipment departed in a C-54 type plane from Hamilton Field, California, on the morning of 13 August and arrived in the Marianas on 15 August. At this point they were joined by other members of the 1st Technical Service Detachment stationed at Tinian. These latter included three civilian physicists (Robert Serber, Philip Morrison, Penney), one medical corps officer (Capt. James Nolan) and several intelligence and administrative officers (Major William Uana, and Lt. Col. Peer De Silva). The division of the group into three sections was accomplished as directed, with

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Colonel Warren in charge of the Nagasaki group, Lt. Col. H. L. Friedell in charge of the Hiroshima group and General Farrell and General Newman in charge of the Tokyo group.

The Nagasaki group left Tinian on 16 August, flew to Guam, and left on the following day on a L.S.V. type ship. After 5 days, they were transferred to a destroyer and taken to Okinawa, where they were billeted at the Naval Operations Base for a period of 28 days.

The Hiroshima group remained for several days on Tinian, and were then transported to Zambo Ango.

The Tokyo group was flown by special plane to Okinawa.

The arrival of the three groups in Japan, and their activities there were as follows:

a. The Tokyo group arrived at Yokohama on 7 September accompanied by Colonel Warren and Captain Nolan from the medical section. Preliminary inspections of Hiroshima and Nagasaki were made on 8-9 and 13-14 September, respectively. At this time preliminary measurements of persistent radioactivity were made and some patients observed.

b. The Nagasaki group was flown from Okinawa by special plane and arrived at Omura on 20 September, and together with Drs. Serber and Penney, two photographers who had been attached to the group, and one ophthalmologist from the theatre, spent 16 days examining patients; interviewing survivors and collecting preliminary casualty statistics; collecting pathological specimens; measuring residual radioactivity; and evaluating physical damage.

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c. The Hiroshima group were flown to Tokyo by special plane on 3 October, and after several unsuccessful attempts to reach Hiroshima because of the weather, finally arrived there on 5 October. This group spent 4 days occupied with activities similar to those of the Nagasaki group.

d. Departure of the three groups occurred for the most part in three main movements, although individual members, particularly of the Tokyo group, had reported back to the United States at earlier dates. Return was by special planes (C-54) via Tinian. In general, the Nagasaki group landed at Hamilton Field on 10 October, and the Tokyo group on 12 October, and the Hiroshima group on 15 October. From there, the various members of the mission returned to their proper stations.

7-6. Preparation of Report.

a. The material brought back, from which a report was prepared, was distributed as follows:

(1) The main portion of photographs, interview notes, etc., were brought to Oak Ridge;

(2) The specimens for study of radioactivity and the pathological material were sent to Rochester, N. Y., for analysis;

(3) The clinical data was sent to Rochester, New York, for statistical analysis.

b. The final report was prepared and written as follows:

(1) The physical damage study was prepared and written by Majors Youngs and Varley.

(2) Analysis of soil samples, photographic film, and other objects was done by Capt. Tybout with assistance from Drs. Bale

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and Dessauer at Rochester.

(3) The pathological specimens were prepared and studied by Major Howland.

(4) Statistical analysis and writing of the clinical section was done by Capt. Barnett, with the assistance of Major Howland, Mr. Wantman and Mr. Tiedeman at Rochester, N. Y. and Washington, D. C., respectively.

c. The various sections of the report were collected and edited by Capt. Barnett in Washington and the final report of the findings submitted to General Groves and distributed to Rochester and Oak Ridge in May 1946.

6-7. Follow-up Study. - During the time of study in Japan in September, 1945, the Manhattan District group was joined by personnel from three other independent units. A large group of medical corps officers and technicians, organized from the theatre under Colonel A.W. Oughterson, arrived in the two cities late in September. A much smaller group under Commander Shields Warren, representing the Naval Technical Missions in the Pacific, also arrived. From the outset, a large group of Japanese physicians under Dr. Tsao Tsusuki, representing the Japanese government, had been active in the investigation. The Joint Medical Atomic Bomb Investigating Commission was established in the field at this time. This consisted of the Manhattan District group and the three units mentioned above, under the direction of Colonel A. W. Oughterson, who headed the largest component, and whose group stayed to complete a thorough study. The material collected by this commission, (including records on 14,000 persons and approximately 150 autopsies) was brought

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to the Army Institute of Pathology in Washington, D. C., in January 1946, the major portion of the field work having been completed in early December 1945. Study of the material was carried on at the Army Institute of Pathology and the Biometrics Division of the Office of the Air Surgeon. This was under the general direction of Colonel A. W. Oughterson, and the immediate supervision of Lt. Colonels G. V. LeRoy, A. Liebow, and Major E.V. Hammond. Manhattan District participation in this study consisted of:

a. Active participation and liaison work by Captain Barnett.

b. Employment of personnel for work on the project. These included Drs. Oughterson, LeRoy, Barnett and Rosenbaum (after their separation from active duty), and in addition several code clerks and other technical assistants.

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SECTION 8 - HISTORY OF MEDICAL PARTICIPATION IN "OPERATION CROSSROADS".

8-1. General Statement. - President Truman indicated that personnel protection at Bikini was obligatory and that the tests must be carried out without mishap to any individual. The responsibility for this obligation was assigned to Captain George Lyons, United States Navy Medical Department. The nature of the operation required division of duties into the various highly specialized fields, such as Radiologic Safety and Damage Control Safety. Colonel Stafford L. Warren who had directed the radiologic aspect of the safety program of the entire Manhattan District was selected as Chief of the Radiologic Safety Section for Joint Task Force One.

8-2. Planning. - Protection involved consideration of not only Joint Task Force One Personnel, but also Army and Navy personnel on the nearby atolls of Eniewetok and Kwajalein, as well as the natives inhabiting Bikini and nearby areas. Consideration was given to meteorlogic conditions so unfavorable as to endanger people in Japan and the United States.

Plans were aimed at two specific categories of danger; first, that from the initial detonation; and second, that from radiation persisting after detonation. The latter arose chiefly from fission products. Fissionable material and matter in which radioactivity had been induced also contributed to persisting radiation.

Safety from the hazards of the detonation was to be insured by the evacuation of personnel from the Bikini Atoll. The distance which was considered safe was estimated from the observed effects of the

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three previous bombs and by theoretical calculations. The natives of Bikini Island were evacuated before the arrival of most of the Task Force.

The danger of persisting radiation was to be evaluated continuously and extemporaneously as the occasion demanded. Radiation measurements were carried out in the manner of the Manhattan District Project work with some modifications for particular situations. Fission products and other active matter were to be traced by ship, plane, and land vehicle as the instance demanded. When this became impossible, estimates of the ultimate fate of a mass of radiating matter were made on the basis of meteorlogic data.

Manhattan District personnel and qualified civilians from outside the district were used as a nucleus for the training of additional officers who were to be needed in the carrying out of these plans.

8-3. Personnel. - Medical officers were selected from the Navy, the Army Ground Force, and the Army Air Force to make up a training group.

A great share of the members of the Radiological Safety Section were recruited from the various areas of the Manhattan District. They were individuals who had participated in some way in the safety program of the district for the preceding years.

Many well known scientists, by invitation, made up a part of the complement. They acted in one or more of three categories; observers, advisors to Colonel Warren, or actual participants.

8-4. Training. - The Training Group were ordered to Oak Ridge in mid January 1946. At this time the indoctrination program was started

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under the supervision of Colonel Warren. His chief aides were Lt. Col. Hymer L. Friedell, M.C.; Capt. Fred Bryan, M.C.; Capt. Birchard Brundage, M.C.; Capt. Robert Buettner, M.A.C.; and Lt. Leonard Rasmussen, M.A.C.

The context of the study at Oak Ridge was pointed to a fundamental understanding of nuclear reactions with particular emphasis upon those reactions which were concerned in the manufacture of and detonation of an atomic bomb. Particular stress was placed upon an understanding of the separation of uranium isotopes as carried on at Oak Ridge. Didactic programs were supplemented by field trips to the Gaseous Diffusion Plant, the Electromagnetic Separation Plant, and Clinton Laboratory. Throughout the course there was a vigorous attempt to transmit to trainees a realization of special hazards and a working knowledge of devices and methods used in protection.

On 12 and 13 February 1946, the group left Oak Ridge for additional training at the University of Chicago, the University of Rochester, and the Philadelphia Navy Yard. At both of the Universities, lectures and demonstrations of current biological research relating to the toxicology of fission products and fissionable material were presented. The deleterious effects on protoplasm of both acute and chronic radiation exposure were discussed. At Philadelphia, Capt. Lyons and his assistants introduced the group to the Navy "Rebreathing Unit". An inspection of the Cruiser Prinz Eugen and the Battleship New York was undertaken so that members of the Radiologic Safety Section would have some idea of the structure of a ship.

At Los Alamos on 4 March, 1946 lectures and demonstrations as well as field trips were continued. The special problems and hazards as

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encountered at Los Alamos were emphasized. The fundamental aspects of field monitoring for radiation were inculcated. This was done in a very realistic and practical manner by virtue of a field trip to "Trinity", - the site of the initial and historical atom bomb detonation. Dr. Louis Hempleman was most active in this program. At Berkeley, California, during the last two weeks of March, the sites of the various particle accelerators were visited and the group heard additional lectures.

Postponement of the test by the president gave time for additional indoctrination. Officers were sent to Chicago, Hanford, San Diego, and Los Alamos, where actual participation in the experimental and applied procedures of radiation protection occurred.

8-5. Operations. - The Hospital Ship, U.S.S. Haven, served as a means of transport of both personnel and equipment and also served as a base during the entire operation. Embarkation occurred 28 May 1946. Planning and training continued and were pointed to predicted operational situations.

The strategic and tactical details of rehearsals and actual tests can be learned by referring to reports of Commander Kaufmann, U.S.N., who was the operations officer for the Radiologic Safety Section.

The underlying plan of safety from radiation for the entire operation was that officers and men, capable, of detecting radiation by proper application of instruments, and also capable of interpretation of radiation in terms of protoplasmic damage, would be in attendance at all operations occurring in potentially dangerous areas. This

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necessitated sending monitors in the photographic planes, reconnaisance planes, rescue planes, and in all of the various types of water craft.

Colonel Warren and his assistants, Capts. Bryan and Buettner arranged for assignment of the Training Group to positions appropriate to their degree of training and experience. Close liaison was maintained between the Commander of Joint Task Force One and Colonel Warren, who, in turn was in constant communication with the highly dispersed members of the Radiologic Safety Section. By this arrangement, Col. Warren as a staff officer, was able to modify tactical and strategic maneuvers as hazards were encountered and evaluated.

As a result of these relations both tests Able and Baker were carried out with a maximum of protection to personnel. The extraordinary persistence of radiation on target ships following the under water shot taxed the resources and ingenuity of those responsible. It was necessary to impose methods of decontamination upon personnel returning from contaminated areas both for their own and others protection. This was enacted by the utilization of a laundry ship. Every individual who was to board a target ship was required to pass through the laundry ship where he left his own clothing and dressed in special attire. On return from his task he again passed through the laundry ship where he discarded his work clothing, bathed carefully, and finally retrieved his own clothing.

Special precautions included the examination of several thousand urine specimens from exposed individuals. These were done in order that assurance would be available that no individual had in any way acquired appreciable amounts of radiating matter within his body.

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Navy line officers, disturbed, and in some instances chagrined, at the restrictions imposed upon ship inspection and movement by the Radiologic SafetySection, conceived a program of decontamination of ships. In principle such a plan was generally envisaged as of considerable value to the National Defense. Actually the methods and materials applied resulted in extraordinary difficulties of protection to personnel. The dangers of ingestion, inhalation, or absorption into the body by any means of the very innocuous fissionable material or fission products were necessarily increased by the arduous and cumbersome methods of ships decontamination. This situation led Colonel Warren to advise Admiral Blandy that ship decontamination be delayed ultimately. Decontamination was to be carried out on a small experimental basis rather than by a large field scale operation.

An additional problem arose with non-target ships which had been contaminated because of residence in contaminated lagoon water. It was necessary to set up standards of maximum allowable radiation in and about each ship before it would be cleared for embarkation. In the late operational phase several of the members of the training group were required to participate in such clearance. Colonel Warren, with his advisors, suggested temporary standards. The same problem arose with some target ships which were not mechanically disabled but which were radiologically questionable.

On 15 August 1946 many of the members of the Radiologic Safety Section left for the United States on the U.S.S. Henrico. Commander Harris of the Training Group was left in charge of the section at

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Bikini. On the Henrico, plans were designed for the training of additional personnel, particularly Navy, so that the Manhattan District Group could eventually be replaced.

From Bikini, monitors were sent to Guam, Manila, and Pearl Harbor, and ports along the Pacific coast of the United States so that contaminated ships could be intercepted and monitored. Thus a proper evaluation of their danger in "clean" ports could be made.

Early in September 1946, the command of the Radiologic Safety Section was given to Captain Walsh, U.S.N., M.D., of the Western Sea Frontier at San Francisco. At this time many of the tactical units of J.T.F. 1 had reached the Pacific coast ports where they were interred in the various navy years to await final clearance. High priority for these ships led Captain Walsh to order members of the Training Group from outlying bases, including Bikini, to San Francisco.

Late in October, 1946, personnel who had been trained in the program conceived and planned on the Henrico were assigned to Captain Walsh. The employment of this additional group permitted the return of Manhattan District officers and men. Some of the naval officers of the original Training Group continued with the work.

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