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OPERATION BREN

TECHNICAL CONCEPT—OPERATION BREN

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TECHNICAL CONCEPT–OPERATION BREN

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Oak Ridge, Tennessee
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ABSTRACT

The Oak Ridge National Laboratory (ORNL) Health Physics Research Reactor is to be attached to a hoist platform on a 1500-ft tower at the Nevada Test Site (NTS). The project is a continuation of the studies commenced in 1956 for evaluating the radiation doses of persons exposed to nuclear weapons, especially the residents of Hiroshima and Nagasaki, Japan. Measurements will be made of the energy, angular, and spatial distributions of the radiation from the reactor. Various shields, including facsimilies of Japanese houses typical of those in Hiroshima and Nagasaki in 1945, will be studied. Experimentation is scheduled for early 1962.

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Chapter 1

INTRODUCTION

Operation BREN was justified to support Program 1 and will be carried out by the Health Physics Division of the Oak Ridge National Laboratory (ORNL). Program 1 is a continuation of the Ichiban study, which was established in 1956 to evaluate the radiation doses received by survivors of the nuclear bombing of Hiroshima and Nagasaki, Japan, in 1945. Other programs will be conducted by various agencies and groups during and after completion of all the experiments of Program 1.

Since the needs of Program 1 are basic to Operation BREN, scheduling of all operation events, to include timing of experiments, reactor power levels, working hours, etc., will be adjusted to the requirements of Program 1. Most of the operating time will utilize a reactor power level of 1 to 10 kw. Experiments proposed by other organizations which can utilize the radiation fields available during Operation BREN on a noninterference basis can be incorporated into Operation BREN.

Chapter 2

GENERAL OBJECTIVES

2.1 PROGRAM 1: SPECTRA, DISTRIBUTION, AND ATTENUATION OF MIXED RADIATION

Neutron and gamma-ray shielding factors applicable to many of the structures in the Japanese cities must be determined in the course of the experiments to ascertain the radiation doses received by the survivors of the nuclear bombings of Hiroshima and Nagasaki. However, the data must be sufficiently general to permit the calculation of shielding factors for a wide variety of shielding configurations. Therefore, most of the work is of fundamental nature and applicable to general radiation physics problems.

2.2 PROGRAM 2: GAMMA-RAY MEASUREMENTS, SPECTRA and DISTRIBUTION

Program 2, which is scheduled to commence after the completion of Program 1, is an extension of aerial radiometric studies performed at the Nevada Test Site (NTS) in 1960 over the Civil Effects Test Operation (CETO) Extended Source Calibration Area (ESCA). The ESCA will be rebuilt with one corner at the base of the BREN tower. Radiation detectors will be installed in the hoist car and located at elevations between the ground and the top of the tower. The results will permit comparison with 1960 data for use in further development of aerial radiometric equipment and calibration thereof over a large area of uniform contamination.

2.3 PROGRAM 3: EVALUATIONS OF RADIATION SHIELDS

The general objectives of this program are to evaluate the shielding characteristics of various materials in various configurations to mixed fields of neutrons and gamma rays. This study will extend a program of evaluation conducted at ORNL.

2.4 PROGRAM 4: NEUTRON FIELD AND SPECTRUM AND DEPTH-DOSE STUDIES

The general objectives of this program are to measure the spectrum, flux, and dose rates of neutrons from an unshielded reactor supported on a tower. Measurements will be made at ground level to a horizontal distance of 1500 yd from a point under the reactor. Foil-activation and counting techniques will be used in addition to BF_3 and polyethylene-lined proportional counters and nuclear-emulsion film. Depth–dose measurements will be made in phantoms.

2.5 PROGRAM 5: NEUTRON-FIELD AND INDUCED-ACTIVITY MEASUREMENTS

The general objectives of this program are to determine some of the characteristics of the neutron distribution in soil, e.g., fast neutron to thermal neutron ratios, resulting from operation of an unshielded reactor mounted on a tower at several heights above the ground as a function of horizontal distance from a point directly under the reactor and as a function of depth in the soil and to determine the induced radioactivity in samples of selected materials as a function of the same parameters.

2.6 PROGRAM 6: RADIATION EFFECTS ON ELECTRONIC COMPONENTS

The general objectives of this program are to determine the effects of mixed fields of neutrons and gamma rays on electronic components of interest in missile systems. Included in the study are the effects of pulses of radiation (i.e., dose rate), integrated exposure, and the electromagnetic pulse associated with a nuclear pulse on the performance of these electronic components.

Chapter 3

GENERIAL EXPERIMENTAL PROCEDURE

The ORNL Health Physics Research Reactor (Fig. 3.1) will be mounted on a hoist car on a 1500-ft tower in Area 4 (Fig. 3.2) at NTS. The reactor will be the source of neutrons and gamma rays and will be operated in the steady state at a power level of up to about 10 kw. During the second phase of the study, the reactor will be pulsed (approximately 10^{17} fissions/pulse), and the spectrum of the fission-product gamma rays will be studied as a function of time after burst. After the reactor has been removed from the tower, a Co^{60} source of about 1200 curies will be placed on the hoist car to permit measurements of a gamma-radiation field from a "point" source, i.e., all the gamma rays are emitted from the source, whereas, in the case of the reactor measurements, many originate from neutron scatter and capture at a distance from the reactor source.

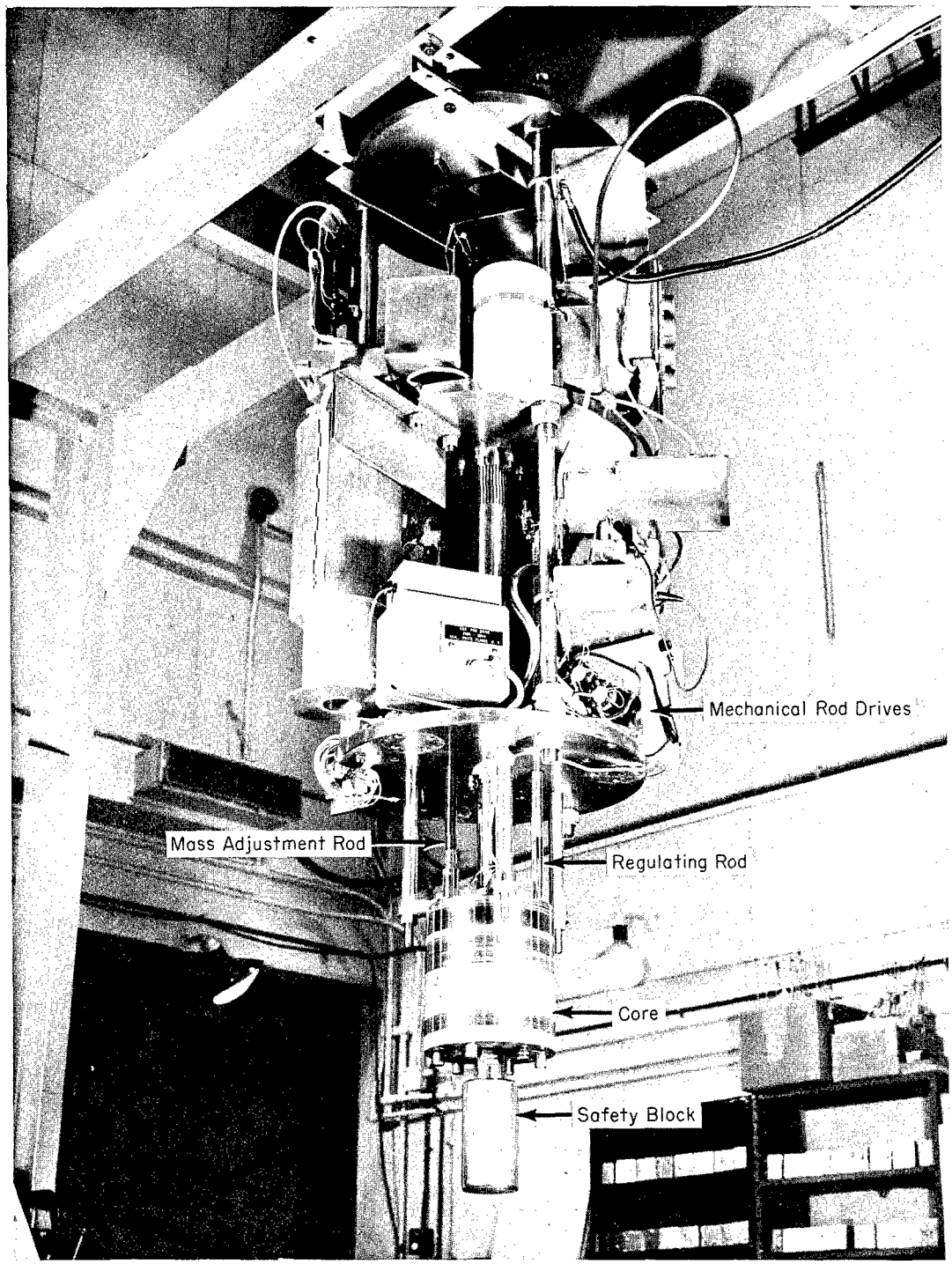


Fig. 3.1—ORNL Health Physics Research Reactor.

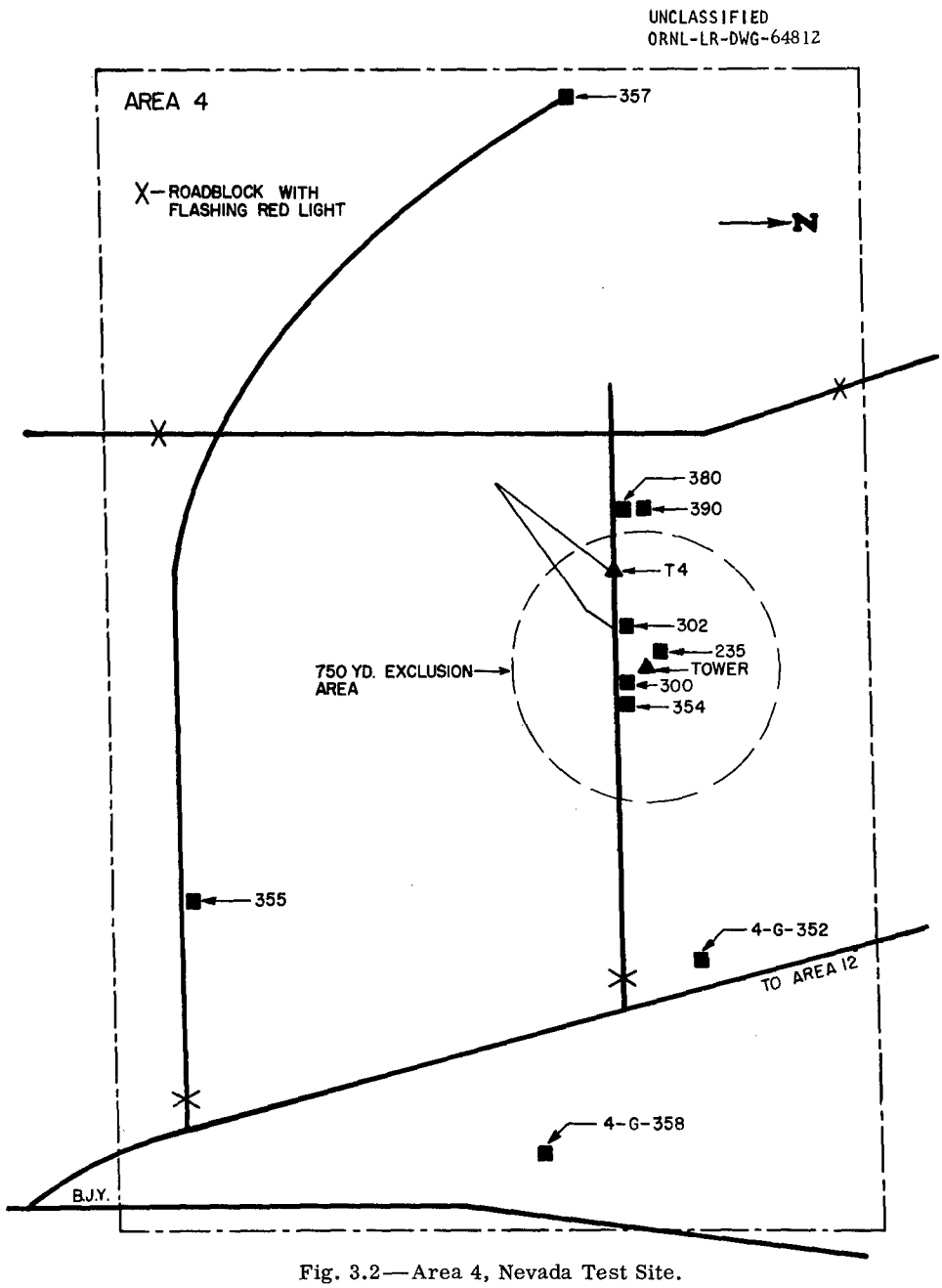


Fig. 3.2—Area 4, Nevada Test Site.

Chapter 4

GENERAL OPERATING PROCEDURES

Area clearance (sweep) will be concluded before operation of the reactor (or the 1200 curie Co^{60} source) is initiated, and all roads will be barricaded; flashers, sirens, and signs will be used as warning devices. Radiation-detector stations on the tower, at the bunker, and in the experiment area will be monitored continually during operation. Regular and special health-physics (Rad-Safe) monitoring of all personnel will be required throughout the period the experiments are in progress, i.e., for the period that persons participating in the experiments are at NTS. After shutdown, personnel will not be permitted access to the reactor tower area until released by the Technical Director or his approved representative.

Chapter 5

OPERATING PROCEDURES AND RESPONSIBILITIES

5.1 TECHNICAL DIRECTOR

The Technical Director (TD) shall be responsible to the Director of CETO for the performance of all operational and technical phases of Operation BREN. Operation of major radiation sources (the reactor and the 1200 curie Co^{60} source) will be under his direct control. A complete, detailed operating log will be maintained for the TD by the reactor operator which will document starting and stopping times, power level, and source height for each operating period together with other pertinent information as directed by the TD.

Use of relatively small calibration sources will not be under direct control of the TD.

The Deputy Technical Director (DTD) shall represent the TD in operational and technical matters as required.

The Operations Officer will maintain contact with Office of Field Operations (OFO)-NTS through CETO and will adjust BREN operating schedules to avoid conflict with other activities at NTS. He will inform OFO-NTS of scheduled reactor or Co^{60}-source operation a minimum of 24 hr in advance and will report start-up and shut-down times for each operating day. He will keep OFO-NTS informed of operational developments that might affect other activities at NTS.

The Radiological and Operational Criteria Officer shall assist the TD in formulating and carrying out the Rad-Safe plan to prevent radiation injury to participants in Operation BREN or to others at NTS and in off-site areas. He shall be responsible for area surveys before, during, and after periods of operation, as required, and shall keep the TD informed of radiation hazards. He shall maintain liaison with the Rad-Safe Officer-NTS and CETO to ensure compliance with applicable NTS procedures. He shall maintain a log that will document all radiation surveys, instructions issued, and important decisions concerning radiation safety.

The Radiation Source Operations Officer shall be responsible for actuation of the mechanisms for providing the radiation to meet the programmatic needs within the limitations of his facilities and consonant with safe operation of those facilities.

C-1, C-4, and C-6 (see the organization chart on p. 20) shall be responsible to the TD for administrative services, material and support services, and engineering and construction services, respectively, under normal CETO arrangement.

5.2 PROGRAM DIRECTORS

The Program Directors (PD) shall be responsible to the TD for the conduct of their respective programs and the personnel involved therein.

The PD's shall keep the TD informed as to the progress, needs, safety, and preferred schedule of their respective programs.

The PD's must inform the TD, according to an established schedule, as to whether their programs will have personnel in the Forward Area during each operational period. PD's shall provide the TD with a muster list of program personnel in Area 4 at a specified time prior to the start of any operational period.

The PD of Program 1 shall coordinate the projects in Program 1 to obtain the necessary data with a minimum of reactor operation and on a schedule that will provide adequate time for maintenance and construction.

5.3 PROJECT OFFICERS

Project Officers (PO) shall be responsible to their PD for obtaining the data required by the objectives of their respective projects.

The PO's shall be responsible for the procurement, placement, maintenance, and operation of instrumentation required by their respective projects.

The PO's shall keep their respective PD's informed of progress, safety, scheduling, special needs, disposition of personnel, and other matters pertinent to their respective projects.

5.4 REPORTS

All reports, including day-to-day liaison, to OFO-NTS from the TD or subordinates shall be channeled through the TD and CETO.

Written progress reports shall be submitted through the TD to CETO on a mutually agreeable schedule.

Interim reports shall be submitted by all projects and programs to the TD at the completion of experimentation before departing from NTS.

Each PD will submit a final report by project to the Director, CETO, through the TD, for publication as a CEX report. A draft of each report must be submitted within six months of the conclusion of Operation BREN.

Chapter 6

ORNL HEALTH PHYSICS RESEARCH REACTOR

The assembly will be operated while rigidly attached to a hoist car located on the east side of a triangular 1500-ft tower near Bldg. 4-300. The hoist car will consist of two compartments; the upper one will house a relay rack, which holds the preamplifiers, etc., and the lower one will house the reactor assembly, which will be solidly attached to a plate in the roof of the lower compartment (rated to support 2500 lb). The structural members of the hoist car will be angle beams, and the floor of the lower compartment will be of light construction. Covers will be provided to protect the reactor from rain, snow, or dust. The hoist car is constructed of aluminum to reduce perturbation of the radiation field from the assembly.

Height of the hoist car during operation will range from approximately 25 to 1500 ft above grade.

A separate elevator will be provided for personnel; it will be located inside the triangle formed by the tower legs.

The assembly will be fueled only after installation in the hoist car and complete checkout of control circuits. It will then be loaded in the proper fuel configuration as determined experimentally at ORNL before shipment to NTS.

Chapter 7

RAD-SAFE PLAN

This Rad-Safe plan pertains to the operation and use of the ORNL Health Physics Research Reactor and a 1200 curie Co^{60} source in relation to Operation BREN.

This plan covers the operations under all programs of Operation BREN.

1. Each user group participating in Operation BREN will use NTS personnel monitoring as required in NTSO-0524.

2. ORNL employees will also wear the ORNL standard film badge, with an additional fast-neutron film packet, to keep Laboratory personnel records current.

3. Groups other than ORNL will comply with the requirements of NTS plus those of the respective parent organizations.

Initial steps to be taken relative to personnel safety are:

1. Bio-assay techniques will be required in determining the body background of personnel prior to participation in Operation BREN.

2. All parent organizations of personnel participating in Operation BREN are required to submit records showing the amount of radiation their personnel have received through occupational exposure.

Control of radiation exposure will be followed as described in NTSO-0524.

The exposure limit for Operation BREN will be 3 rem/quarter (gamma plus neutron) except in the case of an emergency. However, in no case will the accumulated exposure at NTS combined with previous occupational exposure exceed the maximum permissible dose (MPD) = 5(age - 18) for any individual.

Each PD will be issued information indicating the radiation hazard in his area at all times when the reactor or gamma source is in use.

A routine monitoring program will be established compatible with the reactor operating schedule and will be under the direction of the Rad-Safe Officer.

In the event of a radiation emergency, proper reports will be channeled to OFO-NTS through the TD and CETO.

Cleanup of contamination resulting from a reactor accident would follow normal NTS procedures. Exposure provisions of NBS Handbooks 59 and 69 would apply. Emergency services of the NTS support contractor would be requested.

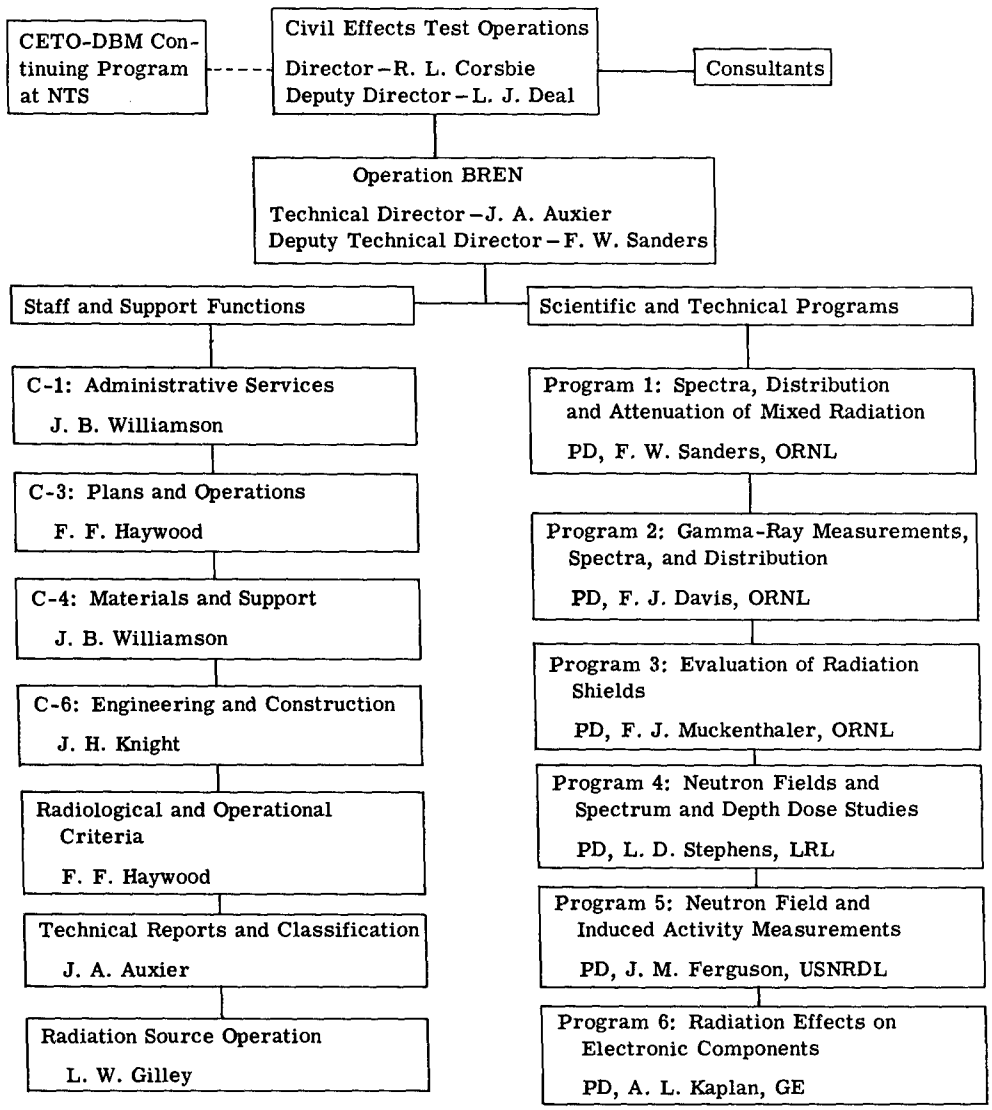
PD's will register with the TD all radioactive materials used in relation to their programs.

The reactor and gamma source will be shipped to NTS in accordance with AEC regulations.

Chapter 8

ORGANIZATION AND RESPONSIBILITIES

The organization chart for Operation BREN, showing responsibilities, is given below.



CIVIL EFFECTS TEST OPERATIONS REPORT SERIES (CEX)

Through its Division of Biology and Medicine and Civil Effects Test Operations Office, the Atomic Energy Commission conducts certain technical tests, exercises, surveys, and research directed primarily toward practical applications of nuclear effects information and toward encouraging better technical, professional, and public understanding and utilization of the vast body of facts useful in the design of countermeasures against weapons effects. The activities carried out in these studies do not require nuclear detonations.

A complete listing of all the studies now underway is impossible in the space available here. However, the following is a list of all reports available from studies that have been completed. All reports listed are available from the Office of Technical Services, Department of Commerce, Washington 25, D. C., at the prices indicated.

CEX-57.1 ($0.75) The Radiological Assessment and Recovery of Contaminated Areas, Carl F. Miller, September 1960.

CEX-58.1 ($2.75) Experimental Evaluation of the Radiation Protection Afforded by Residential Structures Against Distributed Sources, J. A. Auxier, J. O. Buchanan, C. Eisenhauer, and H. E. Menker, January 1959.

CEX-58.2 ($0.75) The Scattering of Thermal Radiation into Open Underground Shelters, T. P. Davis, N. D. Miller, T. S. Ely, J. A. Basso, and H. E. Pearse, October 1959.

CEX-58.7 ($0.50) AEC Group Shelter, AEC Facilities Division, Holmes & Narver, Inc., June 1960.

CEX-58.8 ($1.00) Comparative Nuclear Effects of Biomedical Interest, Clayton S. White, I. Gerald Bowen, Donald R. Richmond, and Robert L. Corsbie, January 1961.

CEX-58.9 ($1.25) A Model Designed to Predict the Motion of Objects Translated by Classical Blast Waves, I. Gerald Bowen, Ray W. Albright, E. Royce Fletcher, and Clayton S. White, June 1961.

CEX-59.1 ($0.60) An Experimental Evaluation of the Radiation Protection Afforded by a Large Modern Concrete Office Building, J. F. Batter, Jr., A. L. Kaplan, and E. T. Clarke, January 1960.

CEX-59.4 ($1.25) Aerial Radiological Monitoring System. I. Theoretical Analysis, Design, and Operation of a Revised System, R. F. Merian, J. G. Lackey, and J. E. Hand, February 1961.

CEX-59.13 ($0.50) Experimental Evaluation of the Radiation Protection Afforded by Typical Oak Ridge Homes Against Distributed Sources, T. D. Strickler and J. A. Auxier, April 1960.

CEX-59.14 ($1.75) Determinations of Aerodynamic-drag Parameters of Small Irregular Objects by Means of Drop Tests, E. P. Fletcher, R. W. Albright, V. C. Goldizen, and I. G. Bowen, October 1961.

CEX-60.1 ($1.75) Evaluation of the Fallout Protection Afforded by Brookhaven National Laboratory Medical Research Center, H. Borella, Z. Burson, and J. Jacovitch, February 1961.