MARSHALL ISLANDS FILE TRACKING DOCUMENT

Record Number: 22

File Name (TITLE): Fall-out Gamma Ray Intensity

Document Number (ID): 6186

DATE:

Previous Location (FROM): CIC

AUTHOR:

Addditional Information: Originally issued as Report UCRL-5125

OrMIbox: 2

CyMIbox: 1

6186

Defense Documentation Center

Defense Logistics Agency

Cameron Station • Alexandria, Virginia

UNCLASSIFIED

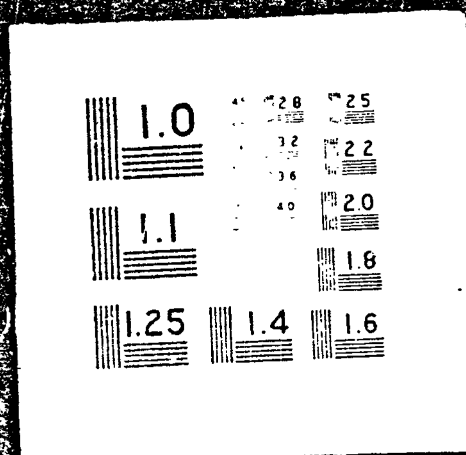
THIS REPORT HAS BEEN DELIMITED
AND CLEARED FOR PUBLIC RELEASE
UNDER DOD DIRECTIVE 5200.20 AND
NO RESTRICTIONS ARE IMPOSED UPON
ITS USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

1 OF 1

AD 467226



Operation IVY

PACIFIC PROVING GROUNDS

November 1952

Project 6.3

FALL-OUT GAMMA RAY INTENSITY

Issuance Date: October 27, 1953

JOINT TASK FORCE 132

Report to the Scientific Director

FALL-OUT GAMMA RAY INTENSITY

By
Melvin P. Klein

Originally Issued as Report UCRL-5125.

University of California Radiation Laboratory
Livermore, California
January 1958

QUALIFIED

PROJECT 5.3

FALL-OUT GAMMA RAY INTENSITY

OPERATION IVY

Report prepared by: Melvin P. Klein

ABSTRACT

Measurements of the intensity of fall-out gamma radiation as a function of time and distance from the Ivy Mike and King shots are reported. Instruments were placed around Eniwetok Atoll and at several atolls in a southerly semicircle with respect to Eniwetok. Contrary to expectations the winds prevailing at the time of the Mike shot were south or southeasterly and no fall-out gamma radiation with the limits of detectibility was measured at any location other than Eniwetok. The gamma radiation measured on Eniwetok Atoll was considered normal fission fragment radiation which decayed with a $t^{-1.2}$ characteristic.

ACKNOWLEDGMENTS

Other people beside the author who worked and participated in Project 5.3 are: Richard L. Blumberg, Harold E. Brown and David D. Cudaback, all of UCRL, Livermore, California.

CONTENTS

ILLUSTRATIONS

FALL-OUT GAMMA RAY INTENSITY

1 INTRODUCTION

Knowledge of the fall-out pattern of a large thermonuclear device is essential for proper evaluation by military as well as test planners and personnel. In order to learn something of the fall-out characteristics of the first thermonuclear device an experiment was designed to measure the fall-out gamma ray intensity as a function of time and spatial disposition with respect to ground zero.

Implementation of this experiment was achieved by placing completely self-contained measuring instruments at a large number of locations distributed around the shot island and varying in distance from approximately one mile to several hundred miles.

2 MEASUREMENT LOCATIONS

Instruments were installed on the following islands of Eniwetok Atoll: Bogallua, Ruchi, Teiteiripucchi, Engebi, Bijiri, Aniyaanii, Parry, Eniwetok and Rigili. Additional stations were established at the following sites: Roi, Kwajalein, Majuro, Ponape, Bikini, Ujelang and Kusaie. These latter locations were selected as a compromise between the most desirable distribution of sites and logistic accessibility for installation and servicing of the instruments.

3 EQUIPMENT

In order that the equipment be as versatile as possible with respect to both gamma intensity and measurement locations the following features of the equipment were considered to be essential:

(1) A lower limit of 5 mr/hr sensitivity with a dynamic range of six orders of magnitude since no previous data were available as a guide to the intensities to be expected.

(2) Complete self-containment and self-calibration so that the equipment could operate in the open without attendance for an extended period.

The manner in which these requirements were satisfied will be given below with a description of the equipment.

4 ELECTROMETER

The central feature governing the design of the equipment was that of the extended dynamic range. This immediately suggested that the recording instrument plot the logarithm of the radiation intensity. The electrometer employed was based on a circuit developed by C. W. Johnson of LASL. A circuit diagram of this device is given in Fig. 1. The circuit consists of a differential amplifier the output of which is proportional to the logarithm of the ionization chamber current. The limiting sensitivity of the circuit was approximately 10^{-12} amperes. The output of the unit was linearly proportional to the logarithm of input current over a range in excess of six decades. Since the units were to be self-contained and to operate unattended at remote locations they were powered by batteries. Variations in operating characteristics due to gradual decrease of battery voltage were accounted for by providing for periodic self-calibration. This was achieved by injecting known currents into the circuit at four-hour intervals by a cam-operated switch on the clock-driven recording milliameters.

The units operated satisfactorily for approximately five days which was the maximum length of time the clock motors operated.

The low currents to be measured together with the high values of resistance in the circuit necessitated exclusion of all water vapor. This was achieved by containing the electronics in an air-tight housing pressurized slightly with dry nitrogen gas.

5 IONIZATION CHAMBER

The limiting sensitivity of the electrometer, 10^{-12} amperes, together with the requirement that the apparatus possess a sensitivity to gamma radiation of 5 mr/hr, dictated that the ionization chamber have a sensitivity of about 10^{-9} ampere/r/hr. Since no commercial ionization chambers of this sensitivity were available it was necessary to develop one with the appropriate characteristics. The resulting chamber was a high pressure, multielectrode Argon chamber with a sensitivity of approximately 2×10^{-9} amp/r/hr. Figs. 2 and 3 show, respectively, an exploded view of the chamber, and a view of the assembled chamber together with the electrometer housing.

6 PROTECTIVE HOUSING

The electrometer, ionization chamber, recording milliameter and batteries were contained in rugged aluminum boxes which could be handled by two men and could withstand exposure to any weather which might be encountered at those locations where no protective shelter was available. Aluminum radiation shields placed over the boxes precluded any "greenhouse" effect from occurring. An undue temperature rise in the boxes could have undesirable effects; a high temperature could create irreversible changes in values of the components in the electrometer leading to instability or undue drift, seriously decreasing the life of the batteries and an increase in the ionization chamber pressure beyond the limit of the protective pressure seal.

Figure 4 shows the interior of the housing containing all equipment. Figure 5 is a view of the apparatus completely enclosed.

Provision was made to allow operation with the ionization chambers at a location remote from the electrometer proper and many of the units on Eniwetok were so employed with the electrometers inside blockhouses and the chambers inside protective canisters located outside.

7 CALIBRATION

Calibration of the ionization chambers was carried out by comparison with Victoreen "thimble" ionization chambers which had been previously calibrated. The saturation behavior of the chambers was studied and at the operating voltage of 900 volts the chambers were well onto the plateau. The current collected at 900 volts was in excess of 95 per cent of that collected at 5,000 volts.

At the low and intermediate radiation intensity ranges the sources consisted of radium and a several-curie Co^{60} source. For the high intensity region a one-Mev industrial x-ray machine was employed. By comparing the response to the collimated and uncollimated beams of the x-ray machine it was possible to deduce the solid angle over which the chamber was responsive.

As stated above in the section on the electrometer, at four-hour intervals the sensitivity of the electrometer was checked. This was done by introducing standard currents of 10^{-6}, 10^{-8}, and 10^{-10} amperes into the electrometer in place of the ion chamber current. The range of sensitivity of the equipment was from 5 mr/hr to 5 kr/hr. Each time the instruments were serviced in the field a 25-mc Co^{60} source was used to check the overall operation of the system.

8 RESULTS

The distribution of off-atoll measuring locations in a southerly semicircle about Eniwetok was chosen because the prevailing winds at higher altitudes at the pertinent time of year were considered to be northerly. The perversity of nature revealed itself on shot day as the upper air motion was predominantly toward the north. Accordingly, none of the fall-out was carried over the measuring sites off-atoll. No radiation, within the detectability of the instruments, was indicated at any of the off-atoll sites.

There are plotted on Figure 6 the gamma-ray intensity versus time data for those islands on Eniwetok where data were obtained: Engebi, Runit, Bijiri, Aniyaanii, and Rigili. Parry and Eniwetok suffered no fall-out within the limits of detectability of the equipment. Complete data around Eniwetok Atoll were not obtained because the ionization chambers located on Bogallua, Ruchi and Bogon islands were destroyed by blast and thermal damage. Landline telemetering from Engebi to Parry was installed but did not survive the shot.

The only significant results from the King shot were the Slowex data which have been incorporated into the Project 5.2 report. (See report WT-634.)

9 CONCLUSION

Although the lack of conclusive results from this experiment is in no way a reflection on the operation of the equipment but rather on an unfortunate distribution of measuring sites, the participants in this experiment would not recommend duplicating the equipment for any future experiments of this type.

The advent of the solid-state electronic devices would allow a vastly more compact and less expensive apparatus to be constructed if an experiment of this type were to be repeated. Scintillating phosphors and photomultiplier tubes in conjunction with transistorized amplifiers together with the requisite battery supply would occupy only a fraction of the volume required by the units employed in this experiment.

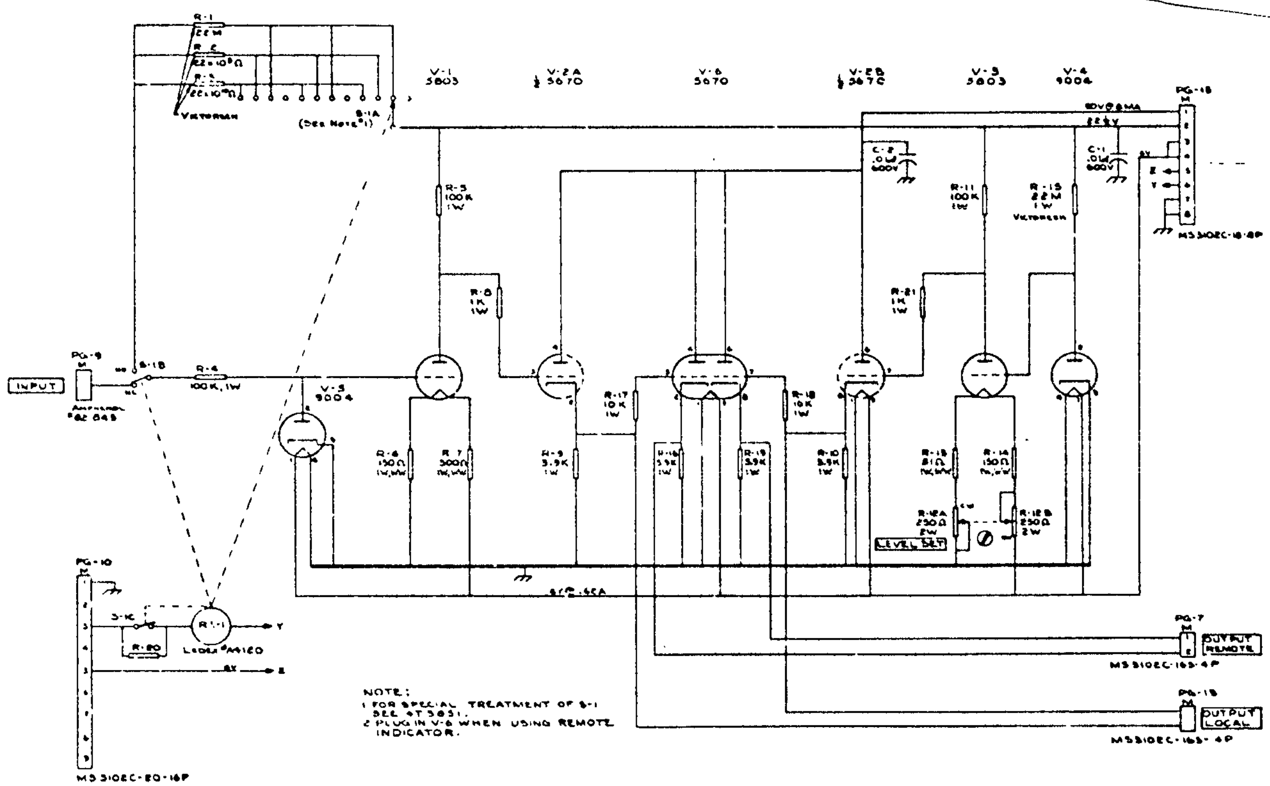


Fig. 1 - Circuit diagram of logarithmic electrometer and accessories.

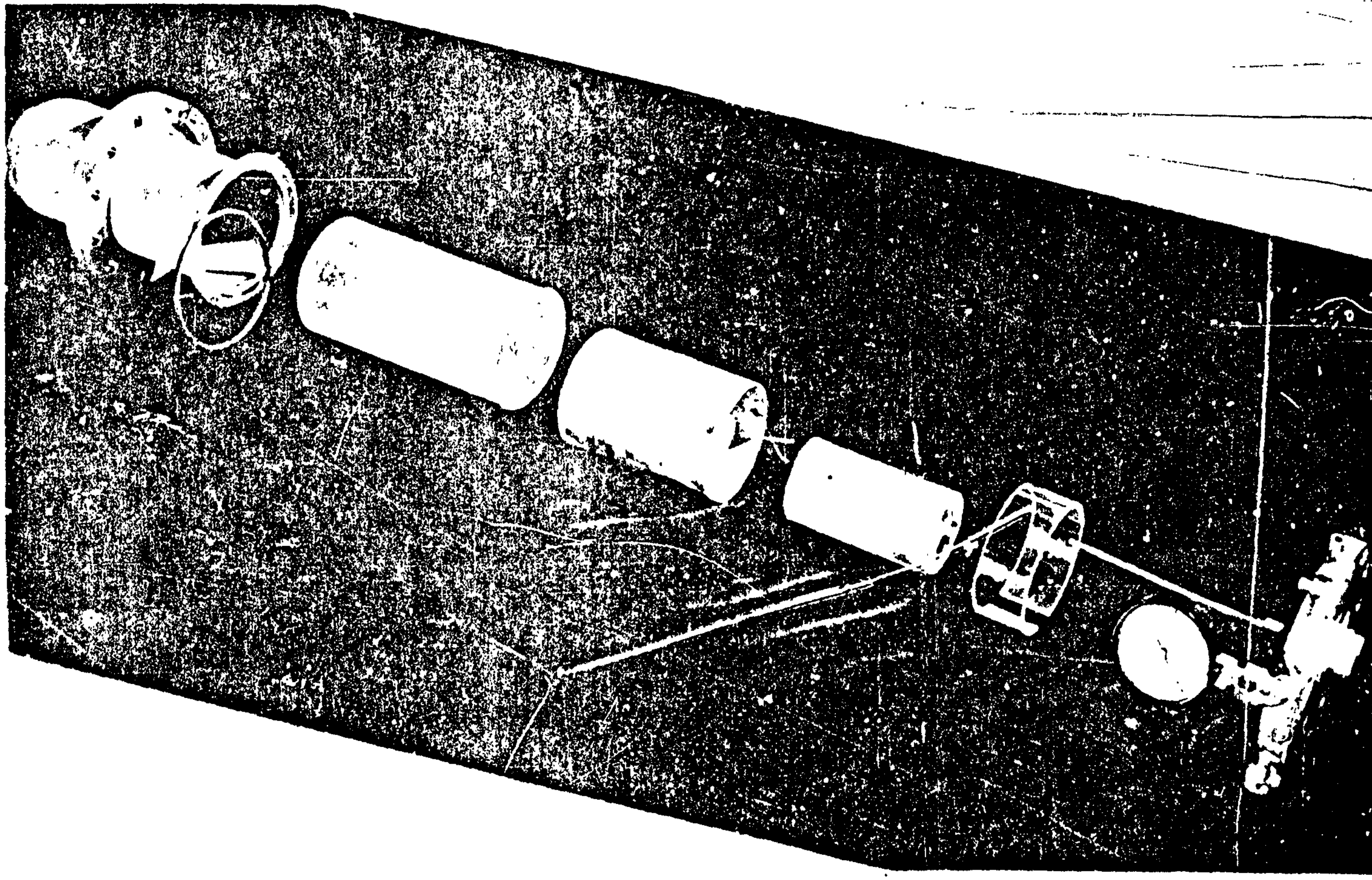


Fig. 2 - Exploded view of ionization chamber.

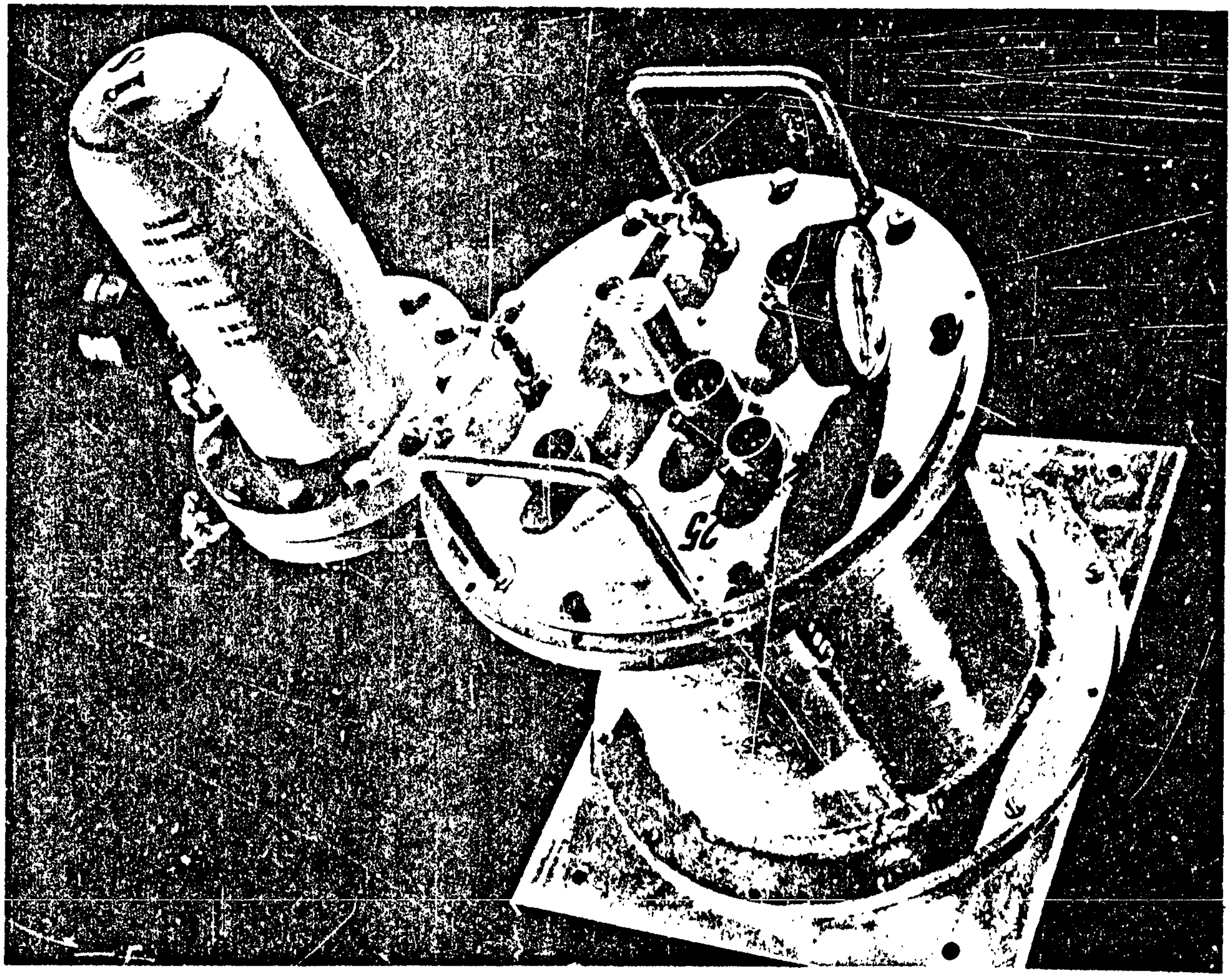


Fig. 3 - View of assembled chamber with electrometer housing.

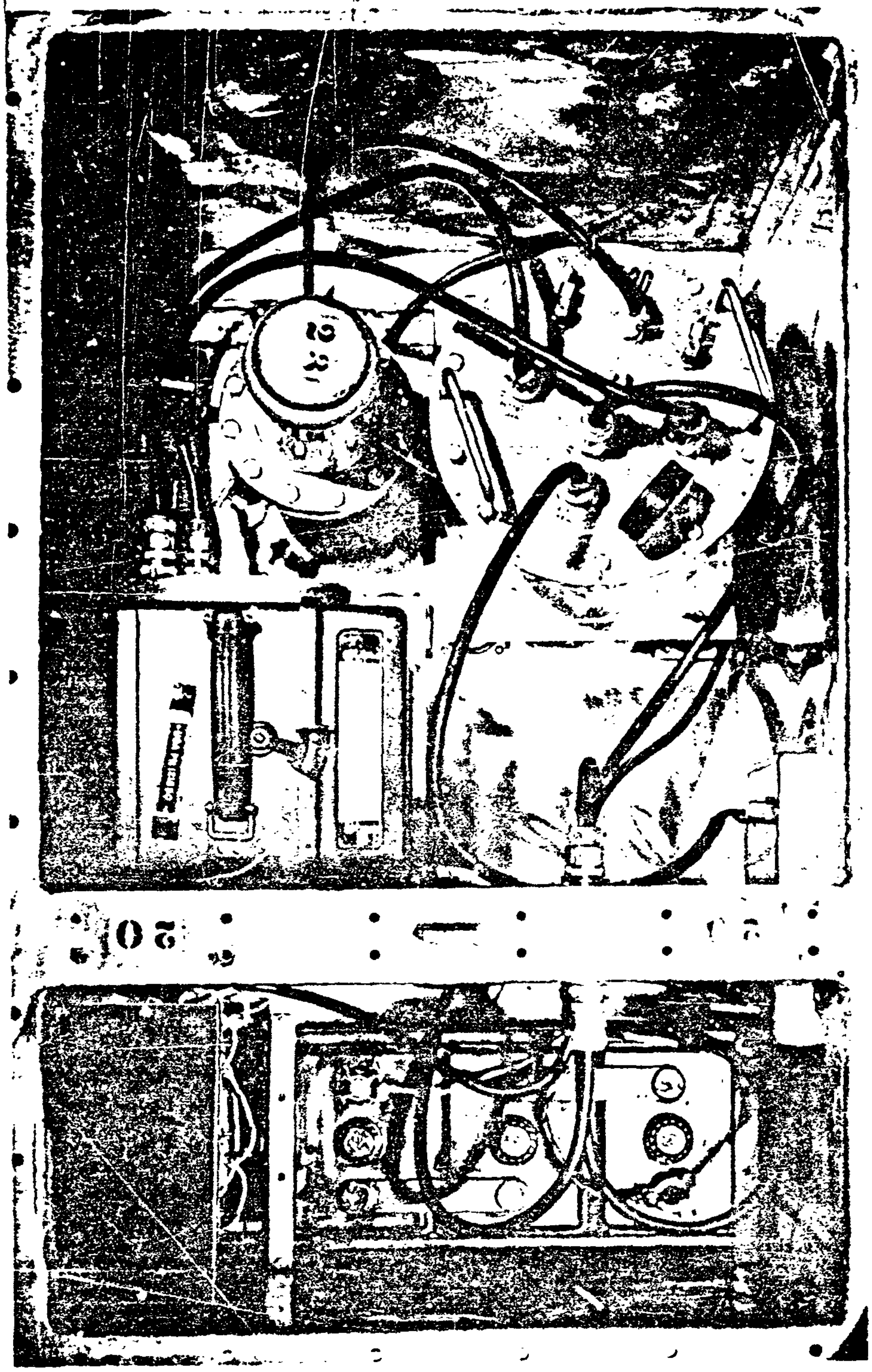


Fig. 4 - View of interior of housing containing the equipment.

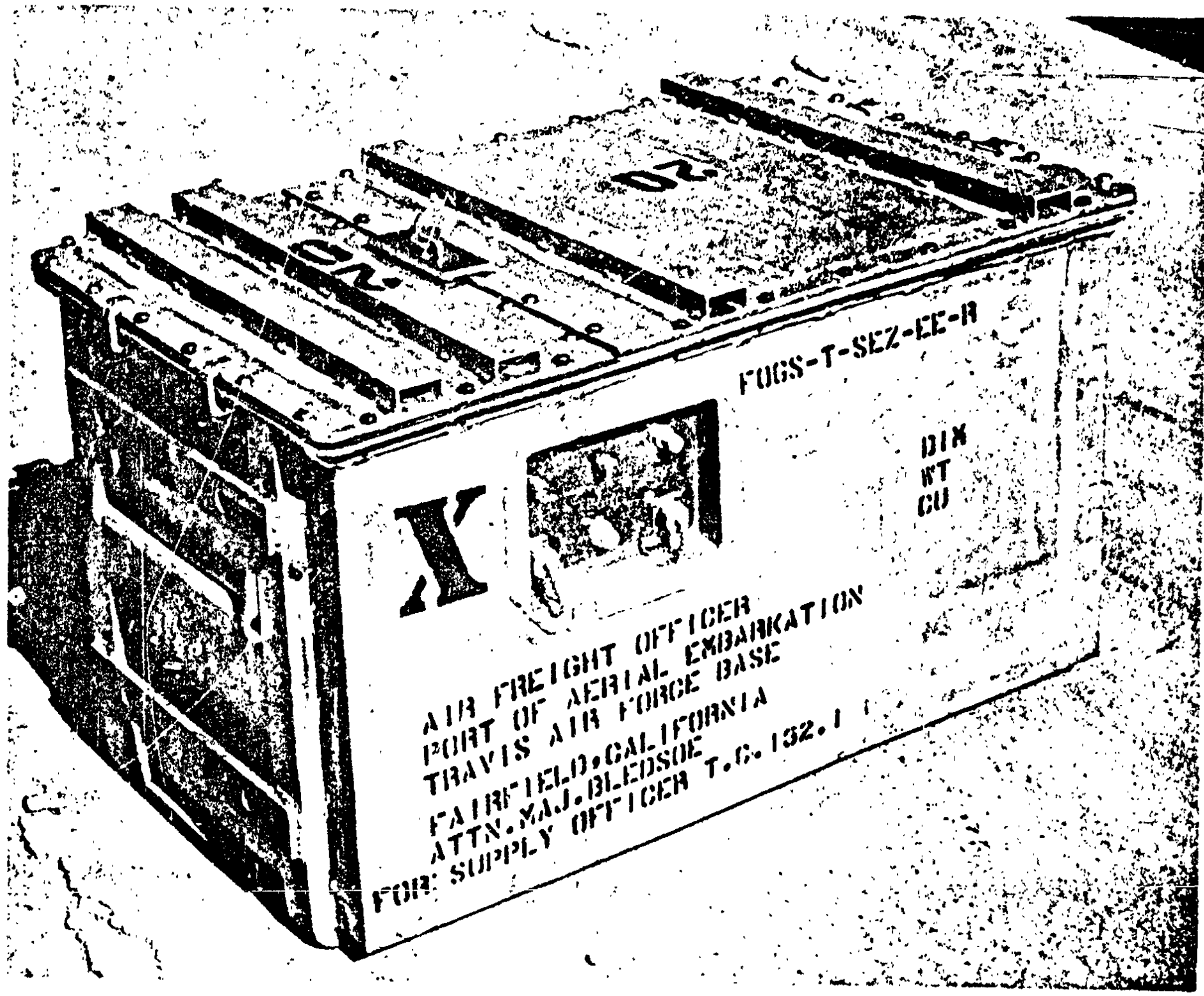


Fig. 5 - View of apparatus completely enclosed.

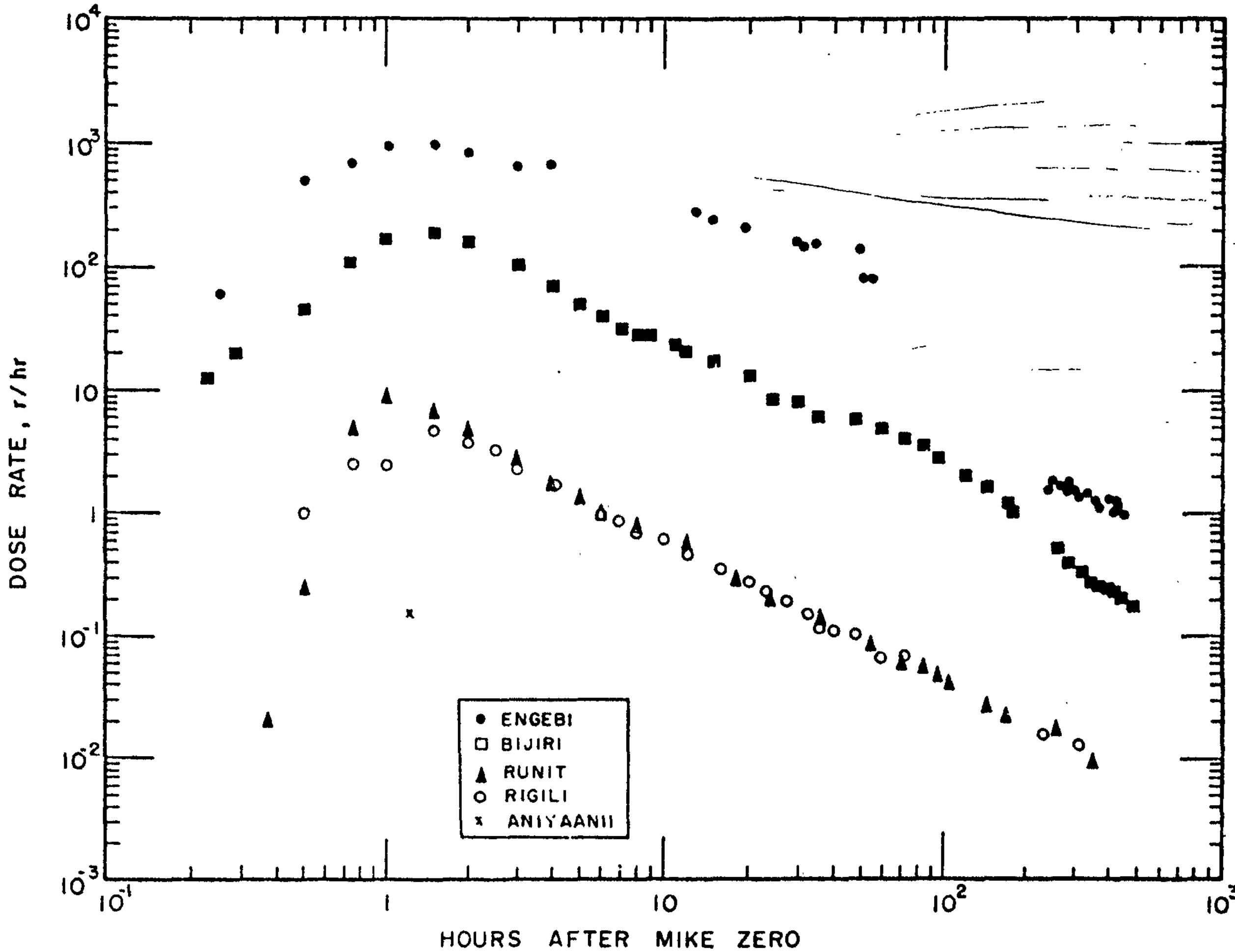


Fig. 6 - Mike fall-out intensity versus time.

END

DATE FILMED

9-65