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With
Very Mild Editing

by

William E. Ogle
and
John H. Lofland, Jr.

8 November 1952
Eniwetok, M. I.

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PROGRAM 5

GAMMA RAY MEASUREMENTS

This program was concerned with the measurement of the gamma ray intensity as a function of time and position, including that due to fall-out, and with the total gamma ray dose as a function of distance. The close up work, under the direction of John Malik, was largely diagnostic, and proposed to determine the time between the two main reactions, and the fission yield. The more distant work was concerned largely with fall-out, and was conducted by Harold Brown of UCRL and LCDR W. B. Heidt and E. H. Bouton for the DOD.

Project 5.1
TOTAL GAMMA-RAY DOSE
Preliminary Report by J. S. Malik

Measurement of total dose as a function of distance was attempted by a film badge holder designed to give data to separate the contribution to the total dose due to nitrogen capture, fission fragments, and fall-out. The holder was a length of aluminum tubing holding one badge released at zero time by the early light burning a string, the badge being exposed for its time of fall into a 5-ft hole giving the nitrogen capture gamma-ray dose; at the same time it initiated a delay which dropped a second badge in 30 sec to give the total dose without the fall-out contribution. One badge was left up permanently and one down permanently for controls. These stations were placed at 100-yd intervals where land was available from 1500 to 6000 yds.

These stations were all nearly totally destroyed, only those at the extreme ranges being recoverable. The stations from 4500 to 6000 yds will probably give meager data but, due perhaps to the low surface brightness of the fireball, the dropping arrangement failed on nearly all stations, giving probably only the total dose from all sources on all badges.

Data from the stations on Bogallua have been recovered and are being analyzed at Los Alamos before attempting further recovery.

Project 5.2
GAMMA INTENSITY AS A FUNCTION OF TIME
Preliminary Report by J. S. Malik

The gamma-ray intensity vs time with a time resolution of 0.1 μsec was recorded at a blockhouse on Ruchi 2500 yds from ground zero, using a system of scopes with linear sweeps ranging from 3 μsec to 1000 μsec plus a dual strip film unit designed to give data for about 30 sec. Satisfactory records were obtained on the linear sweep equipment and on the strip-film units up to shock arrival, which broke through the domes protecting the detectors.

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Gamma intensity vs time measurements with better than millisecond resolution, using strip film units running for several seconds, were attempted at stations on San Il de Fonso (1200 yds), Cochiti (1800 yds), and Bogombogo (4300 yds) to supplement the strip film data of the blockhouse as to the time dependence of the total dose and the effects of the shock wave upon the gamma radiation. The near station was at the edge of the crater and hence wrecked; the station on Cochiti lost the protective dome permitting the shock wave to wreck the recording unit. The Bogombogo station gave data down to about 30 μsec and lasting for some seconds showing the pronounced influence of the shock wave on the gamma radiation--

the level rising after shock arrival to a factor of 50 above preshock arrival, in good agreement with calculated values.

These data indicate a total of 3×10^5 mols of neutrons were released to the atmosphere and the fragment activity was such as to be produced by a fission yield of [redacted] DELETED Both numbers are very rough since they involve working back through a large amount of air subjected to a strong shock with unknown loading.

An integration of the Bogombogo data, making a guess as to the intensities after 11 sec, yields a total dose of 23,000 roentgens, approximately 20 times the predicted curve based on a 5-MT yield.

Figures 5.2-1 and 5.2-2 are plots of the gamma-ray intensity vs time at the Bogombogo and Ruchi stations, respectively.

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Project 5.3
GAMMA RAY INTENSITY VS TIME
Preliminary Report by M. P. Klein

Gamma-ray intensity versus time detectors were placed in operation on the following islands of Eniwetok Atoll: Bogallua, Ruchi, Bogon, Engebi, Biijiri, Runit, Aniyaanii, Eniwetok, Parry and Rigili. Additional stations were placed on Bikini, Kusaie, Ponape, Majuro, Ujelang, Kwajalein Island and Roi Island in Kwajalein Atoll.

The ionization chambers and their protective cannisters located on Bogallua, Ruchi and Bogon Islands were destroyed by blast and thermal damage. Accordingly, no data are forthcoming from these stations.

Land-line telemetering from Engebi to Parry was installed but the line did not survive the shot. Originally, telemetering from Bogon was planned but an inadequate number of submarine lines precluded this installation.

Data have been recovered from Engebi, Runit, Biijiri, Aniyaanii, Parry, Eniwetok and Rigili. Thus far no data have been recovered from the off-atoll stations although some fall-out has been recorded on Kusaie and Ujelang.

Included herein is a plot of dose rate versus time for Engebi, Biijiri, Rigili and Runit (Fig. 5.3-1). The data plotted are preliminary in nature in so far as the absolute magnitude of the dose rate is concerned but are well within a factor of two in accuracy with the exception of Engebi where the ionization chamber sustained

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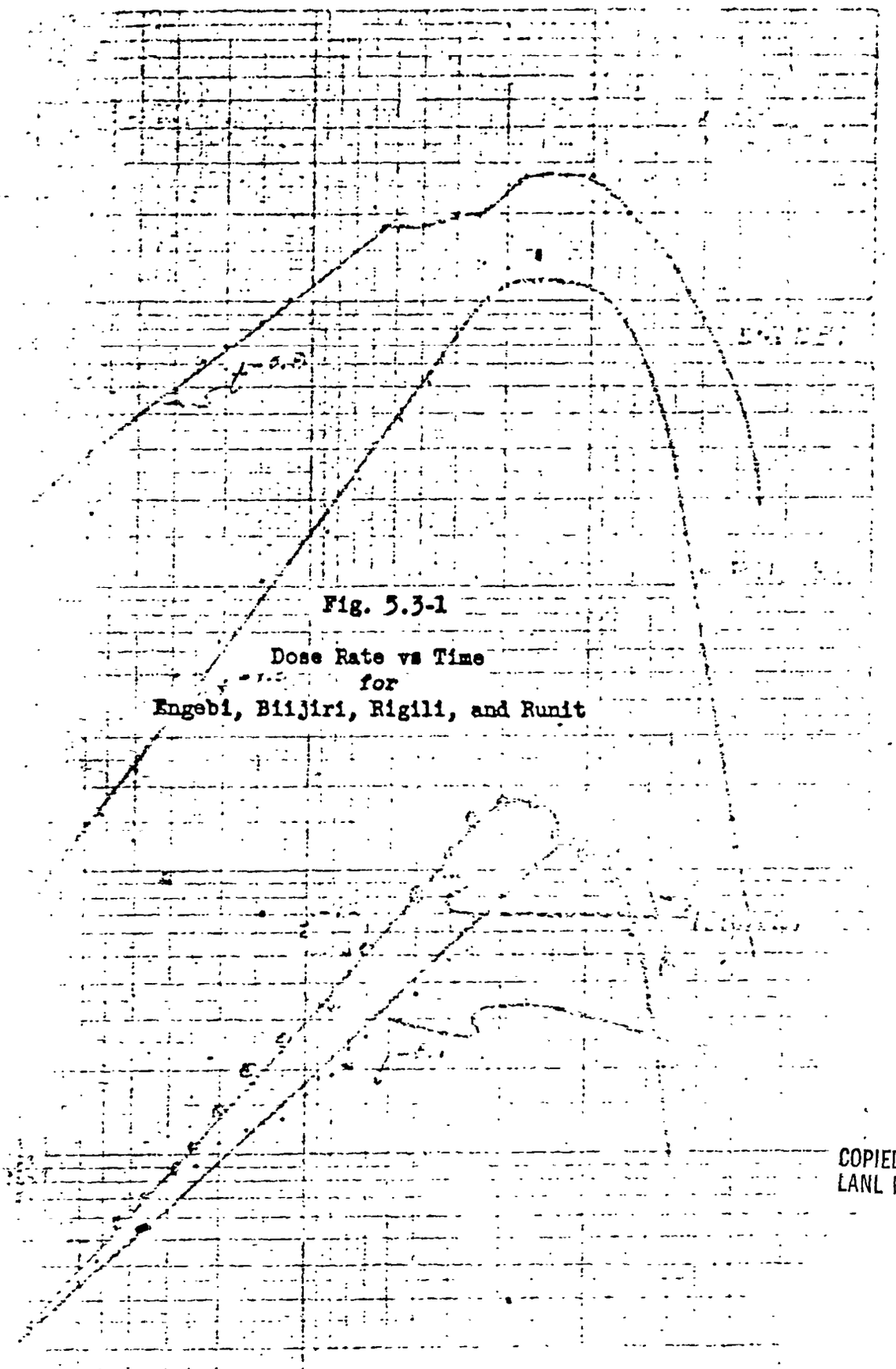
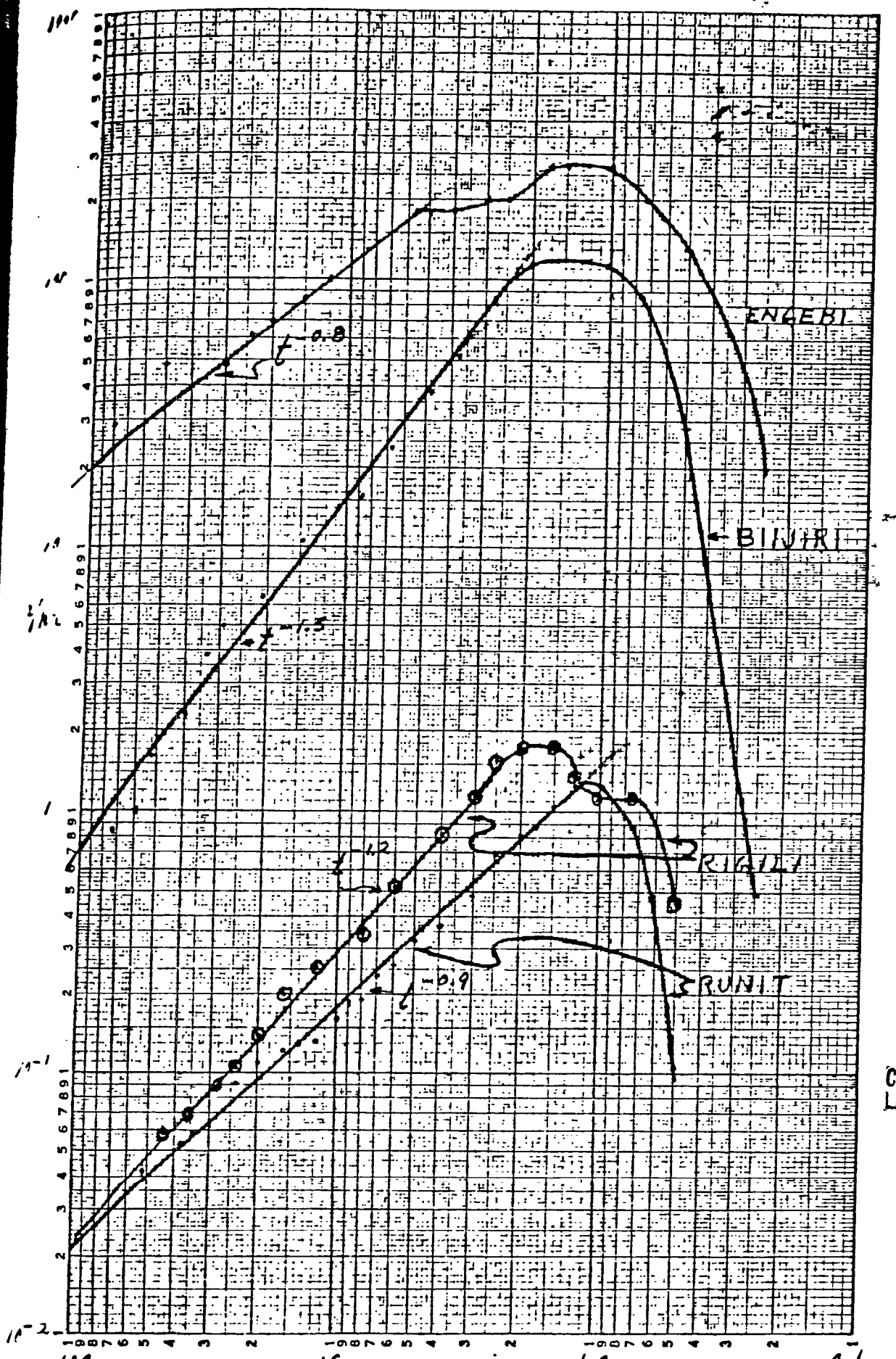


Fig. 5.3-1

Dose Rate vs Time
for
Engebi, Biijiri, Rigili, and Runit



some damage which has altered the sensitivity of the chamber. The decay rates as plotted and calculated are judged to be accurate within plus or minus ten percent. The decay rates indicate the radiation varies as $t^{-1.3}$ to $t^{-0.8}$. No fall-out within the range of the instrument, 5mr/hr to 5 kr/hr has been recorded on Eniwetok and Parry. No data are reported for Aniyaanii as the motor of the recorder failed before shot time.

The scatter of points for times in excess of nine hours is somewhat greater than would be expected for a continuous recording system. It is hoped that a more detailed study may resolve an additional component of the decay scheme such as an exponential factor. This would give rise to a general expression for the decay rate as

$$\epsilon^{-a\tau} t^{-x} .$$

Project 5.4a
FALL OUT DISTRIBUTION AND PARTICLE SIZE
Preliminary Report by W. B. Heidt, Jr.

1. HOW EXPERIMENT DIFFERED FROM TURQUOISE BOOK

The objectives of the experiment have remained unchanged and are essentially as written in the Turquoise Book. The method and procedures varied slightly from that outlined in the Turquoise Book. The following corrections and/or additions should be made:

(a) The Type A collector should be called a total collector rather than an integrating collector as it was called on page 5.4a.3 of the Turquoise Book.

(b) The Type E collectors made use of gum paper as collectors rather than greased plates.

(c) The Eniwetok land station array contained Type A, B, C and D collectors. No Type E (gum paper) collectors were used on the land stations at Eniwetok Atoll.

(d) Type D (a differential collector for solid particulates) collectors were installed at Bikini and Kwajalein.

(e) Type E collectors (gum paper) were installed on Bikini, Kwajalein, Majuro, Ponape, Kusaie, Johnson Island and the following ships: Rendova, Estes, Curtis, Leo, Oak Hill, Agawam, Carpenter, Fletcher, Radford, O'Bannon and an LST off Ujelang. On the island stations these papers were changed each twenty-four hours during the period of M-1 day to about M+7 days. On board ship the gum paper collectors were changed each 12 hours and were placed at a height which would have been above the wash-down system. If it had been

necessary to use the wash-down system the collectors would have given a measure of the fall-out to which the ships would have been subjected without the system. By knowing the ship's position at four hour intervals additional points for the fall-out pattern could be attained.

(f) A total of twenty rafts were anchored in the lagoon. These rafts mounted Type A, B. C and D collectors.

(g) One of the purposes of the experiment was to attempt to measure fall-out in the sea areas surrounding Eniwetok. To do this, Type A (the total collector, i.e., a collecting area funnelling into a flask) and Type E (gum paper) collectors were mounted on Navy dan buoys. In order to make location of the dan buoys easier, a MX-138A corner radar reflector was mounted at the top of the dan buoy staff. The project, as planned, was to ring Eniwetok Atoll, except for the sector occupied by the ships, with buoys so positioned as to be at a distance of 30 miles from the shot island at H Hour. Also planned were two arcs of buoys in the predicted upper air down wind sector (i.e., that 90° sector running from 045° to 135° true). The first arc was to be placed in such a manner that they would drift to 100 miles from the shot island at H Hour; the second arc was to be positioned at 150 miles.

2. DEGREE OF SUCCESS OF THE EXPERIMENT

2.1 Land Stations Within the Atoll

Of the eight land stations, Bogallua, Engebi, Yairi, Piiraai, and Runit were within the fall-out area and, at all stations except Bogallua, some useable fall-out samples were obtained. The Type D, differential solid fall-out collector, was triggered by a "Blue Box" of our own design. On Yairi, Runit, Aniyaanii and Eniwetok the "Blue

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Boxes" failed to trigger. The Bogallua station was demolished so it can not be determined if that station did trigger.

2.2 Lagoon Stations

A total of 20 rafts were placed at their anchored positions in the lagoon on M-15 and M-14 days. A check of the rafts on M-9 and M-8 revealed that two of the rafts plus their buoy moorings were missing. Since the buoys were also missing it is assumed that failure occurred at the anchor or where the cable was joined to the buoy. On M-3 day, during a storm, four more rafts broke loose. On checking it was discovered that the raft mooring lines (3-inch Manila) were being cut by the wire cable about four feet from the buoy. The line, as the raft swung, apparently worked its way up to the "V" where the cable was clamped and was cut due to the heavy working of the raft during the storm. Two of the four that broke loose lodged on the reef between Bogallua and Rigili and were still there after the shot. To correct this difficulty a short section of wire was added to the raft mooring on M-2 day. On M-day, 16 of the 20 original rafts were in position, or approximately so, since the two lodged on the reef were within $\frac{1}{4}$ mile of their original location. On M+2 and M+3 a total of 15 rafts were recovered. The "Blue Box" on all rafts triggered. All of the rafts recovered were within the fall-out area and it is believed that excellent samples were obtained. One of the rafts was at 5 miles from Elugelab and another was $6\frac{1}{2}$ miles. These rafts suffered some blast and thermal damage but satisfactory samples were collected.

2.3 Sea Stations

The first casualty to the dan buoy sea stations was an

administrative one. On M-7 day CinCPac Fleet advised that dan buoys within 75 miles of the shot island constituted an unacceptable limitation on security against submarine penetration. This eliminated all but 19 of the 31 planned buoys. The USS Yuma placed buoys No. 1 through 8 between dawn on M-3 and dawn on M-2 day. The USS O'Bannon placed buoys No. 9 through 19 on M-1 day. The USS O'Bannon was assigned the task of the recovery of the dan buoys and commenced the search at dawn on M+1 day. For the first day a P2V aircraft plane was unable to find a single buoy although about 12 hours was spent in the search. Just before sunset the USS O'Bannon recovered the first buoy. Search was continued until 1000 on M+4 day when it was abandoned. Twelve of the 19 buoys placed were recovered. Of those buoys placed by the USS Yuma, only 3 of the 8 were recovered and of those placed by the USS O'Bannon, 9 of the 11 were recovered. In placing the buoys it had been estimated that they would drift about 270° true at the rate of 18 miles each 24 hours. The average drift of the buoys was 288° true at a rate of 16.9 miles per day. This error, coupled with rainy weather during the first day, hampered search operations. Once the first buoy was found the search operation became easier. Two factors seem to have been responsible for the poor percentage of recovery of the Yuma buoys; one was the additional time in the water and the other was the probability that most of them lost their sea anchors and drifted with the wind. Three of the USS O'Bannon buoys, the last recovered, were without their sea anchors. On other buoys there was evidence of chafing where the line was tied to the buoy. A thimble and a shackle would have overcome

this difficulty and probably assured a greater percentage recovery.

2.4 Other islands and ship stations

Sampling of these stations was not concluded until M+7. The samples have not been recovered as of the date of this report, however, no difficulties are anticipated.

3. RESULTS, COMMENTS AND CONCLUSIONS FROM FORWARD AREA DATA REDUCTION

Since no analysis of the fall-out samples was conducted on site, comments and conclusions can only be very general. All of the samples collected at Eniwetok were placed on the 4 Easy Extra sample flight. The dan buoy samples left via regular MATS flight on M+6 day. All samples will be analyzed at the U. S. Naval Radiological Defense Laboratory at San Francisco.

Visual examination of the fall-out particulate collected indicates that the majority arrived in the form of small round spheres. The spheres vary in size from a pin point to about 1/16 inch in diameter. They are white and will usually shatter at the touch. Some of them appear to be hollow and others appear to have concentric rings. They are insoluble in water and are very tightly stuck to the surface on which they landed. Their tenacity is illustrated by the fact that two of the rafts were towed across the lagoon from a position near the reef between Rigili and Bogallua and, although the rafts were plowing under water for the entire distance, the spheres were not dislodged. The method in which they must have arrived is puzzling. The raft platform was constructed in such a manner that a 2 x 6 board was covered by a 1 x 6 board with a gap of 1-3/4" between them. One of the heaviest concentrations of fall-out lies between these two boards.

It is not only on the top of the 2 x 6 but is on the underside of the 1 x 6. Vertical surfaces of the spacers also show the spheres. In order to have penetrated the aforementioned gap the fall-out must have arrived either in a rolling action, or with a driving force acting almost horizontally. Another interesting note was that the particles seem to have clung just as tightly to the surface of a wooden grating which should have been below the water at all times. This grating was on the underside of the raft and forms a platform inside the raft ring.

Figure 5.4a-1 is a print of a radioautograph, made by placing a piece of tri-X film wrapped in black paper on the surface of the 2 x 6 and leaving it there for a period of 15 minutes. The print clearly illustrates the general nature of the distribution of the fall-out on this surface. The material appears to be of low energy for in a subsequent radioautograph, a double thickness of paper accidentally partially covered the film. This double section very effectively blocked out most of the radiation.

The fall-out seems to have been more heavily concentrated on the western side of the lagoon and extended down to at least 15 miles.

One of the reasons for the approval of the dan buoy stations was to prove the operational feasibility of such a scheme, i.e. could they be found after drifting free for several days. It is believed that the successful recovery of 63% of the buoys definitely proves that such a scheme is feasible. Improved sea anchor connections should increase the recovery percentage. All of the buoys except one which on recovery showed measurable fall-out with survey instruments (TIB's), were to the

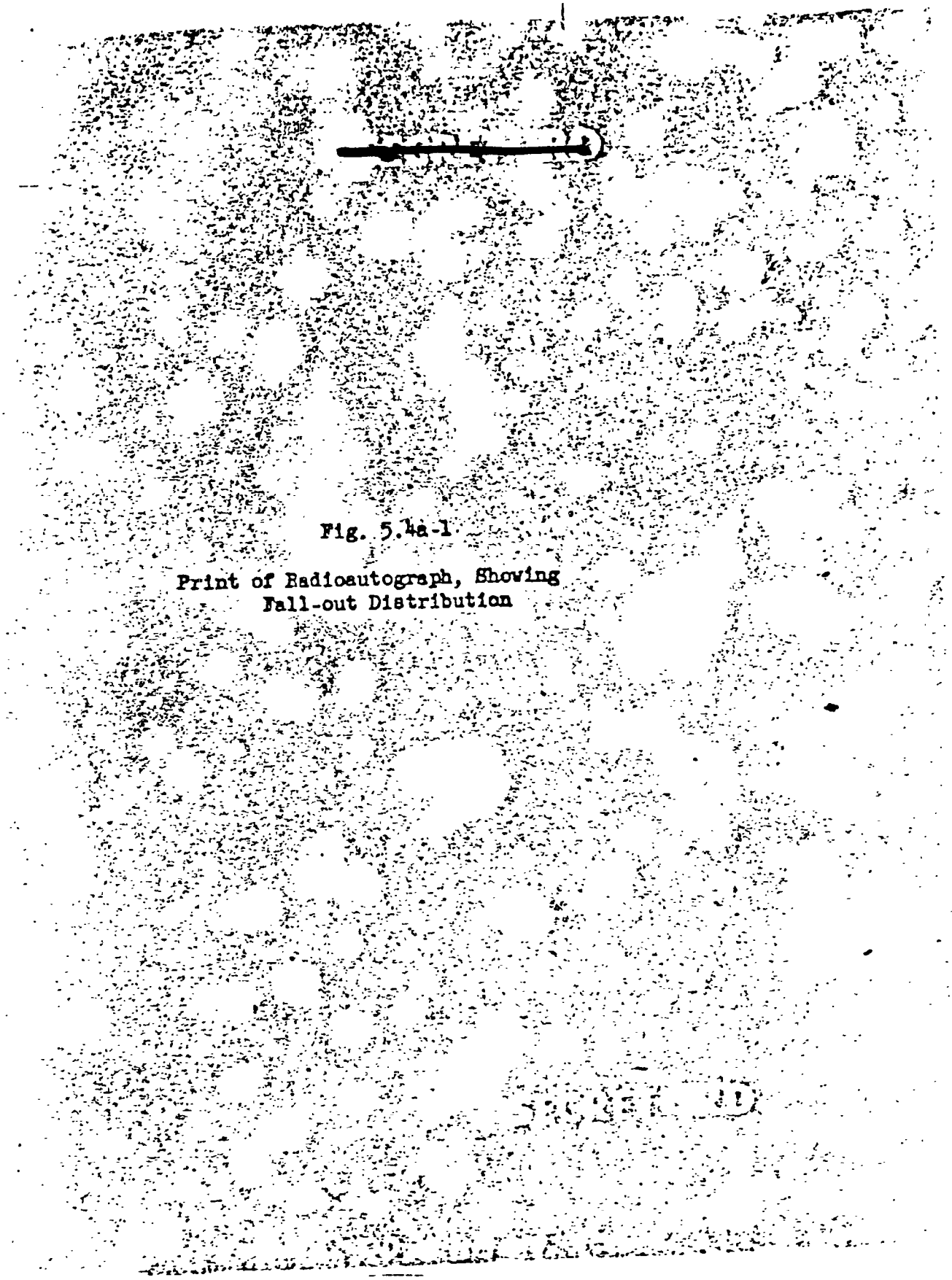

Fig. 5.4a-1

Print of Radioautograph, Showing
Fall-out Distribution

the positive Humidry samples. The quantity of radioactive gases collected in the B-31 device is unknown, as radiac readings were obscured by surface contamination on the B-31 containers. The value of these samples can better be ascertained after preliminary laboratory analyses. All the above samples are now in ZI laboratories and under process.

Project 7.4 - Propagation of Seismic Waves (J. Allen Crocker)

Current reports from Washington, D.C., indicate that six stations received strong signals, one station fair, one station questionable, and no report from one station. Another station reported "no signal"; it is believed that the negative result from this station was due to faulty instrumentation.

It has also been reported that some Coast and Geodetic Survey seismic stations have reported positive signals.

Details of the magnitude of these signals and their respective locations are not currently available at this headquarters.

Project 7.5 - Transportation of Airborne Debris (P. W. Allen)

Data were obtained to determine cloud height and movement after Mike Shot. Because of the conflicting data reflecting the true height of the Mike cloud, conclusions will be held in abeyance until such time that critical evaluation of all data will yield the most probable height and path of the Mike cloud.

Project 7.6 - Detection of Fireball Light at Distances (M. H. Oleson)

No results of this program are available at this time. Measurements

Table A-1

RESIDUAL CONTAMINATION LEVELS*

Place	Time (Days) M	M + 1	M + 2	M + 3	M + 4	M + 5	M + 6
Runit	300	40	100[g]	40[g]	30[g]	30[g]	20[g]
Biijiri	20,000	3,000	1,800	2,000[g]	800	600	240
Engebi	50,000[(a)]	19,000	6,000	3,300	1,800	2,800[g]	1,400
Bokon	10,000[(b)]	--	10,000	14,000[g]	8,000	4,000	2,500
Ruchi	--	16,000	8,000	9,000	3,400	4,000	1,400
Bogallua	7,000[(c)]	14,000	7,000	6,000	3,000	4,000[g]	1,500

*Data taken from RadSafe maps. Numbers indicate intensity in milliroentgens/hour at 25 ft altitude unless otherwise specified. Intensity on ground was roughly four times air reading. These numbers should be considered with caution since they were taken under very adverse conditions and also are, in some cases, interpolated. M represents the day of Mike Shot.

(a) 150 ft altitude

(b) 500 ft altitude

(c) 1500 ft altitude

[g] on ground