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Record Number: 208

File Name (TITLE): Hist ref, TG 132.1, Participation in Mike shot

Document Number (ID): CE8113

DATE: _____

Previous Location (FROM): CIC

AUTHOR: A. S. Knauf

Addditional Information: _____

OrMIbox: 13

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HISTORY - TASK GROUP 132.1

TG 132.1 Participation
in
Mike Shot

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OUTLINE OF HISTORY - TASK GROUP 132.1

TG 132.1 Participation in Mike Shot

I. MX - Rehearsal

II. Firing Party Operations

III. Schedule of Events Prior to Mike Shot

IV. Mike Shot Detonation

V. Re-entry and Recovery

VI. Sampling Activities

VII. Damage Survey

VIII. Residual Contamination Levels

IX. Preliminary Results of Mike Experimental Projects

[redacted]

[redacted]

[redacted]

HISTORY - TASK GROUP 132.1

TG 132.1 PARTICIPATION IN MIKE SHOT

I. MX - REHEARSAL

A comprehensive rehearsal was scheduled by the Commander, JTF 132 to determine the state of readiness of all elements for Mike Shot. The day of the rehearsal (MX Day) was 28 October 1952, and the rehearsal time of the detonation (H-Hour) was 0715.

The dress rehearsal for the Mike event began at 1700 on 27 October and was concluded at about H plus 8 hours on 28 October. Task Group 132.1 participated in the dress rehearsal to the maximum degree practicable without interference with necessary normal operations in preparation for the actual test. The MX Day rehearsal did not include evacuation activities. A complete electronics and communications check was conducted to insure that all circuits and transmitters that were to be used on M Day were actually operated in order that possible interference with critical scientific instrumentation could be discovered.

These checks and the rehearsal of TG 132.1 activities were successfully carried out and no serious deficiencies were noted. The readiness of the Scientific Task Group was affirmed at the Commanders Critique of the rehearsal held at 1900 on MX Day.

[redacted]

[redacted]

After the Commanders Conference which included discussion of the readiness of the task groups, the rehearsal critique, and the weather conference the Commander, JTF 132 confirmed M Day and H Hour as 1 November 1952 at 0715 and issued the execute order for Mike Shot.(1)

II. FIRING PARTY OPERATIONS

Prior to 1800 on M - 6 days, Task Units 3 and 4 had completed preparatory operations for the final filling operations. Cambridge Corporation had two filled hydrogen dewars, one partially filled deuterium dewar, and one emergency standby dewar in the cab area. At about 2200 on M - 6 the cryogenics filling operations begnn. [redacted]

At about 1300 on M - 5 days the assembly group began the first top-off of the reflux dewar. This reflux system was continually monitored and topped-off approximately eight times prior to leaving the device, the last occurring at approximately H - 7 hours. At about 0900 on M - 4 a deuterium sample was taken from the system and sent back to the Los Alamos Scientific Laboratory for analysis. Prior to shot time the Laboratory had analyzed the sample and reported that it was entirely satisfactory.

(1) TWX - 0809 - Dtd 28 1132Z from CJTF 132 to TG Commanders

[redacted]

[redacted]

At 0900 on M - 3 the Firing Party Commander assumed operational control of the shot island group. The mission of the Firing Party was to arm and detonate the Mike device when directed by the Commander, JTF 132. The Firing Party consisted of an Arming Team, a Firing Team, and a Project and Monitor Team.

The mission of the Arming Team was to arm the Mike device, to include making all final connections, test adjustments and calibrations necessary to insure a successful detonation at H-Hour. This Arming Team consisted of six sections: (1) Command and Support Section, (2) CMR Section, (3) Cambridge Corporation Section, (4) Timing and Firing Section, (5) Assembly Section, and (6) Security Section.

The mission of the Firing Team was to operate the Firing Control aboard the command ship and to detonate the device at H-Hour.

The mission of the Project and Monitor Team was to monitor and make final adjustments, tests, and calibrations on vital experimental equipment and necessary facilities. This team was composed of six sections: (1) CMR Section, (2) Cambridge Corporation Section, (3) Assembly Section, (4) NRL-K Section, (5) Powerhouse Section, and (6) Air-conditioning Section.

At 0800 on M - 1 the movement [redacted] from the USS Curtiss was begun. The [redacted] was transported from

[redacted]

[redacted]

the Curtiss at 1100 and the assembly [redacted] began at about 1500. The nuclear insertion was made at about 1600 [redacted]

At about 1730 the security sweep of the island was made and the muster completed for the Firing Party. At 1930 the preliminary television room check was begun. At H - 7 hours the final top-off of the reflux dewar was accomplished. At H - 6 1/2 hours all personnel except the Arming Team departed the Shot Island for the USS Curtiss. At H - 5 1/2 hours the final check out of the cab was completed and the Arming Team then departed for the USS Estes aboard the AVR.

III. SCHEDULE OF EVENTS PRIOR TO MIKE SHOT

The Headquarters of the Commander, TG 132.1 Command Post was activated aboard the USS Estes at 1515 on M - 1 Day. Command conferences were held on M - 2 and M - 1 in which the over-all readiness and weather conditions were discussed. The execute order was confirmed at each conference. On M - 1 the Task Force notified the Atomic Energy Commission and the Department of the Army as to the date and hour of Mike Shot.

On M - 1 Day the bulk of the evacuation of personnel and equipment had been completed by 1800 and the ships got underway for the open sea. The USS Curtiss and the USS Estes, however, remained in the lagoon to evacuate members of the Firing Party

[redacted]

[redacted]

and technicians who were required to remain at their posts until the early morning of M-Day. Final muster reports were made and all personnel were present aboard ships of the Task Force. After the Firing Party boarded the USS Estes, that ship got underway for its shot position at about H - 5 hours on M-Day. The USS Curtiss after departing the Shot Island anchored off Parry to take off remaining technical personnel of TG 132.1 and the special upper air weather detachment from Eniwetok. The Curtiss got underway for its shot position at about H - 3 hours.

The final confirmation of weather forecast was made as of 0300 on M-Day with a very favorable outlook. The aircraft began their take-off at Kwajalein at H - 4 1/2 hours. At H - 30 minutes the Commanders of TG 132.3 and TG 132.4 reported that all ships and aircraft were on station. The final report from the weather sweep plane in the vicinity of the Shot Island was made at H - 20 minutes. The sequence timer started at H - 15 minutes. At H - 10 minutes the two F-84 cloud sniffers were on station and at H - 9 minutes the two canister drop B-29s crossed the ground zero to begin drop of the canisters.

IV. MIKE SHOT DETONATION

The time count broadcast was made from the Command Ship, the USS Estes, on radio channels using a frequency of 126.18 mc. This radio had a range of approximately 100 miles. The time voice broadcast began at 0415 on Mike Day. Instruction and copies of

[redacted]

the time broadcast script were provided each ship in order that the time broadcast could be given on each ship even if the official voice broadcast was lost due to transmission difficulties. This rebroadcast was made on a frequency of 24.8 mc and had a range of approximately 25 miles. Instructions concerning putting on of goggles or turning away from zero point were given on each ship.

Mike Shot was fired at 0714:59.4 ± 0.2 local time on 1 November 1952 at Elugelab Island of Eniwetok Atoll. The error of approximately 0.6 sec was due to a power failure aboard the USS Estes a few minutes prior to the shot. In the transfer to the alternate power system this error was introduced. The shot as witnessed aboard various vessels of the Task Force at sea was a most impressive sight. At distances of 30 to 35 miles, the range within which most of the vessels were positioned, the heat wave was immediately perceptible. The tremendous fireball continued to expand and appeared to be approximately a mile in diameter before the cloud-chamber effect and other clouds obscured the fireball. A very large cloud-chamber effect was visible shortly after the burst. The explosion soon formed a tremendous conventional mushroom-shaped cloud which appeared to have a wide dirty stem and a large billowy white dome. Apparently the dirty stem was due to the coral particles, debris, and water which were sucked up high into the air. About the stem there

[redacted]

[redacted]

appeared to be a curtain of water which fell back into the ocean in the vicinity of the Shot Island.

The shock wave and sound arrived at the various ships in approximately 2 1/2 minutes after detonation and a sharp report followed by a broken rumbling sound was heard by most observers. The pressure pulse and the reduced pressure period as felt by the ear were exceptionally long.

Although the upper cloud at first appeared unusually white, as it ascended to a great height and spread out over the vessels of the Task Force the reddish-brown color could be seen in the boiling mass of the cloud. After approximately 30 minutes the upper cloud was approximately 60 miles in diameter with a stem or lower cloud in the center approximately 20 miles in diameter. The juncture of the stem with the upper cloud was at an altitude of approximately 45,000 ft. Several projecting fingers appeared to be present in the neighborhood of the juncture of the stem and the upper cloud.

The preliminary cloud rise data available shortly after the shot gave the following heights for the top of the mushroom at various time intervals:

Time (min)	Height (ft)
1.5	57,000
2.6	108,000
3.4	110,000
5.7	118,000

The cloud appeared to be stabilized at 125,000 ft after approximately 56 minutes.

[redacted]

[redacted]

Extreme caution must be exercised in immediate forecasts as to whether an atomic or thermonuclear blast went as predicted. The analysis of the many records is of course the final basis for this information. However, based on previous observations of atomic blasts on Operation Greenhouse and knowing the relative yield of these explosions, it seemed very natural to feel confident that the phenomenon just witnessed - Mike Shot - was a far more powerful device than any other detonated to date. Knowing the comparative distances, the sensation of the heat wave, and the visible size of the ball of fire and the cloud effects, it seemed natural to predict that Mike Shot had probably approached the expected yield and was a very significant step in the thermonuclear weapon development program.

Shortly after the detonation the Task Force vessels got underway and moved to an area south of the Eniwetok Atoll. After preliminary radiological safety surveys had been made and the recovery program begun, the following message(2) was sent to all Task Group Commanders by the Commander of Joint Task Force 132.

"The Task Force Commander and Scientific Deputy extend to you a warm aloha for a job exceedingly well done. The detonation was highly successful in every respect, and the scientific surveys and data recovery program are progressing on schedule.

(2)Cite 0878 from CJTF 132 to all TG Commanders, dtd 1 Nov.

[redacted]

[redacted]

"For planning purposes R-Hour (re-entry hour) is 0900 on 2 November. The Commander, TG 132.3 will have the Task Force vessels stand off at both lagoon entrances at 0900, 2 November, pending the outcome of the lagoon water survey. At R-Hour unrestricted radiological safety clearance is declared for Parry, Eniwetok, and all lagoon water traffic south of Japtan. The Radiological Safety Center will open on Parry at Building 57 at 0700, 2 November as the control point for all traffic north of Japtan.

"Upon confirmation of R-Hour commence re-entry operations in accordance with Annex B (Post Shot Re-entry) to CJTF 132 Operational Directive No. 1."

V. RE-ENTRY AND RECOVERY

At approximately H + 10 minutes an aerial survey helicopter took off from the USS Rendova to go directly to Parry Island. This helicopter then flew at an altitude of 25 ft and at a ground speed of about 10 mph over the center of each island in the chain in the direction of the Shot Island. While flying over each island readings were taken with a TIB Survey Meter. This flight had planned to make a complete survey of the Atoll until a reading of 3r/hr was reached. However prior to completion of this mission, this helicopter ran into a rain squall and became somewhat contaminated. It then returned to the USS Rendova where it was decontaminated.

[redacted]

[redacted]

At approximately H + 15 minutes two helicopters were dispatched to Parry to recover data at the photo tower and at the administrative compound. From these early recoveries preliminary analysis of photographic records was begun aboard the USS Rendova. Projects requiring early recovery at Parry Island included the following: Projects 2.1a, 3.1, 5.3, 6.2, 6.4a, 8.3, 9.1, and 9.3.

At H + 40 minutes the TG 132.4 emergency re-entry party went ashore to re-open the airstrip facilities on Eniwetok Island in order to assist in any emergency landing of test aircraft. At H + 45 minutes the utilities crew of Holmes and Narver personnel was taken to Parry Island.

Commencing at approximately H + 2 hours a damage survey of the entire Atoll was accomplished by Dr. W. E. Ogle. The first complete radiological safety survey was made at the same time. The antiaircraft guns of Project 6.2 on Engebi were checked for misfires on this flight. It was found that all guns had fired properly.

The lagoon water survey was made at H + 4 hours. Samples were taken at the anchorages off Parry and Eniwetok. These samples were satisfactory and the radiological safety group recommended that re-entry begin on 2 November. Minor reports of fall-out on M-Day and M + 1 Day on Eniwetok and Parry and on ships in the lagoon were made to the Radiological Safety Center. However, at no time was this fall-out significant.

[redacted]

[redacted]

R-Hour was established as 0900 on 2 November after extensive ground surveys on Eniwetok and Parry Islands. By 1200 on this date the radiological safety unit set up headquarters in Building 57 on Parry, to act as a control point for recovery operations. Recoveries on M + 1 Day were made both from the Rendova and Parry Island.

The priority of re-entry of TG 132.1 personnel was based upon the need of scientific personnel to complete recovery operations and to prepare for King Shot. Some TG 132.1 personnel remained afloat for several days since the Holmes and Narver support facilities were not adequate to provide for all personnel during the first two or three days after re-entry. The Holmes and Narver re-entry was accomplished in the following order: (1) all division heads and doctor, (2) men to float and man the M-boats, (3) men to restore and operate the power, water, and telephone systems, (4) complete mess hall complement, and (5) maintenance crews as needed.

All personnel going ashore on the morning of M + 1 Day were provided with lunches for the noon meal. The Holmes and Narver mess hall was open for the evening meal. Gradually the number of personnel ashore was increased as Holmes and Narver was able to provide support facilities. All personnel of TG 132.1 were ashore by M + 4 days.

[redacted]

[redacted]

Beginning with M + 1 scheduled radiological safety surveys were made of northern islands of the Atoll. The recovery operations were carried out in general, as planned with changes made where radiological hazards existed or damage to installations made recovery difficult. (See Paragraph VIII on Residual Contamination Levels.)

The USS Curtiss returned to the Eniwetok lagoon to discharge certain passengers and equipment on 2 November 1952. This ship then departed to Kwajalein where its mission was to provide shop facilities and berthing facilities within capacity for TG 132.1 operations and personnel in support of preparations for the King event.

The USS Curtiss arrived at Kwajalein the afternoon of 3 November with approximately 80 passengers of TG 132.1 aboard. These personnel included members of Task Units 2, 3, and 4 whose work in the Forward Area was completed. Air transportation to the ZI for this group was arranged at Kwajalein.

After 3 November, L-13 aircraft were authorized to proceed north of Runit without a radiological safety monitor provided they did not land and flew at a minimum altitude of 850 ft directly over the edge of the reef on the ocean side of the Atoll. The return flight was to be made by turning in the area of Bogallua and following the same or higher altitude and the same course to base. Film badges were required on all such

[redacted]

[redacted]

flights. Unrestricted re-entry was declared on 3 November for Aniyaanii and Japtan including lagoon traffic to these islands. Small boats were further authorized to travel in the northern half of the lagoon if they cleared with the radiological safety control unit and were accompanied by a monitor from Task Unit 7. Boat crews could go ashore provided protective clothing and film badges were worn.

Similar instructions were issued as radiological safety conditions permitted for entry into other northern islands. Work at Runit was authorized on M + 2 days in order that preparations for King Shot could begin.

VI. SAMPLING ACTIVITIES

Cloud sampling by the F-84G jet aircraft began at approximately H + 1 hour and was completed at approximately H + 5 hours. A total of 12 samples were obtained by the F-84G aircraft, including the two used for early reconnaissance.

Samples in general were taken at altitudes between 42,000 and 44,000 ft in the region of the juncture between the upper mushroom and the stem. In general, these samples were considered to be as representative of the cloud as possible.

A prearranged system for reporting operational data to the control B-36 aircraft was used and included such information as altitude in thousands of feet, time of penetration, peak radiation intensity in the cloud in roentgens per hour, and whether snap samples were taken.

[redacted]

Two of the sampling aircraft ran low on fuel and attempted to land at Eniwetok Island. One of the planes landed safely at Eniwetok and the sample was recovered. The other aircraft crashed off Eniwetok and neither pilot nor plane could be recovered.

Test samples of the Mike cloud were returned to laboratories within the United States by means of special MATS flights from Kwajalein. Flights after Mike Shot were numbered 1E through 4E. Joint Task Force 132 provided courier personnel for each flight. AFOAT-1 and Army Chemical Center, who shared the majority of the samples being transported, provided couriers at the point of first landing in the US for the remainder of the flight.

Flight 1E departed Kwajalein within approximately 3 hours after Mike Shot and arrived at Hickam Air Force Base at 011107Z. This flight departed for Kirtland Air Force Base within an hour. Flight 2E followed 1E by approximately 2 hours and made similar stops. Both of these flights contained samples collected by the sampling aircraft. Flight 3E departed Kwajalein at 020556Z, arrived at Hickam at 021828Z and departed for Travis Air Force Base after a little over an hour stopover. Flight 4E departed Kwajalein at 031200Z and arrived at Hickam at 040837Z. An extra flight 4E left Eniwetok on 5 November and completed the sample return program for Mike Shot.

[redacted]

VII. DAMAGE SURVEY

A damage survey of Eniwetok Atoll was accomplished by Mr. Francis B. Porzel, Director of the Blast Measurements Program, approximately 48 hours after Mike Shot. The following are extracts from a report prepared by Mr. Porzel covering the conditions he found on various islands of the Atoll.

Eniwetok

General

No damage of consequence occurred on Eniwetok Island from Mike Shot except as noted below. Of interest are the facts that five L-13's and one P2V aircraft were parked in the open without damage, a movie screen was left up, and water tanks were intact.

A sewer line from Eniwetok pulled loose at the water line and was laterally shifted below the water line. This is difficult to understand because there is no evidence elsewhere of water wave action or ground shock of comparable intensity.

B-29 Hangar

This is an extremely large structure - about 200 ft long - covered by a roof span of 150 ft of cantilever construction with hinge points at the bottom and top center.

[redacted]

[redacted]

The main doors had been left open and it was originally intended that large portions of the side sheeting would be removed. This was not done because in the few days prior to shot time the reasonable risk did not appear to justify the manpower required.

The building was racked slightly and the center line of the roof span sagged downward about 6 inches front and rear. The front arch was diagonal to the blast and appears to be out of round with its closest corner buckled down and its far corner buckled up. The large sliding hangar doors cannot be closed on either end; they are out of their tracks on the uplifted front corner and elsewhere they could be closed about half way until prevented by roof sag.

The damage and roof sag are evidently due to the peak pressure impulse. The fill time of the building must have been about 100 milliseconds, because of the large size. Here and there, corrugated iron sheeting has been buckled a few inches by multiple reflections on the interior.

The roof sag can probably be corrected by jacking up the roof back into place with hydraulic jacks on poles under the center arch.

[redacted]

[redacted]

Parry

1. Blast

a.) Tent flies were torn on pyramidal tents on the side facing the blast. This generally occurred in the front or exposed rows. These tears occurred at the seams.

b.) Wooden pipes were broken at the elbow just beyond the buildings. This was probably due to the racking of the buildings. Of two cases, one was a plastic elbow.

c.) Corrugated sheet iron was blown loose from the warehouses on the back side from the blast at the intersection of the wall on the floor. This was probably due to multiple reflection on the interior of the building. The sheeting was about rusted-through, in any case.

d.) At the CMR building a large stack of radiator coils, about 12 ft square, was pushed in about 3 inches. A heavy cabinet near the interior wall was knocked down. Air-conditioning pipes, 2 1/2 ft across, were pushed in a few inches. The roof ventilators were out of round about 3 inches. This may not have been due to the blast, but possibly to damage on installation.

[redacted]

[redacted]

2. Water Waves

Water waves were less than 1 ft above high tide line.

3. Thermal Radiation

No effects.

Runit

Rafts were upright and moored. Floats were moored. The pliofilm covers were still on the launchers and intact. Oil drums were on their bases There was no thermal charring. The pressure level as measured by the Sandia group was 1.3 psi. Thermal radiation was about 2 calories total. There was no water damage and only light pressure damage.

Rojoa

Rafts were upright and moored. Palm trees were standing and not scorched.

Biijiri, Aomon, and Eberiru

The brush was bent away from the blast. There was slight charring of leaves. Damage was beyond the moderate level.

Kirinian

The first suspicion of washing occurred here. Loose tin and debris were scattered about the island.

Engebi

The guns on this island were intact, but badly rusted. Grass was green at the base, but the upper part was scorched.

[redacted]

The island appears as if it had been washed by water carrying the burnt debris away, but this impression may be due only to the blast wind followed by severe rains.

Bogon, Bogairikk, and Teiteiripucchi

These islands and the rest of the chain down to Bogallua were swept clean. There is a fine deposit of coral sediment over the reef rock. Nothing was left of the Krause box which suggests a jet which exploded it, and violent wave action to sweep away the debris. The odor of dead fish was first noted on Bogon.

Crater - Elugelab

1. The crater extends from the west end of Teiteiripucchi but not so far as San Ildefonso, and is about 1 mile in diameter.
2. The depth is difficult to judge because of turbidity. The water is green in the crater and may be as shallow as 10 meters and probably not over 20 meters.
3. The reef is continuous on the ocean side but has many deposits of coral sand piled up as in the lip of a crater. It is essentially a different reef surface.
4. The crater is not yet stable. There are sharp edges of turgid region which should have diffused by now, after 48 hours.

[redacted]

[redacted]

VIII. RESIDUAL CONTAMINATIONS LEVELS

The following data have been compiled from radiological safety maps over the period M Day to M + 6 days. The numbers indicate the intensity in milliroentgens per hour at a 25 ft altitude unless otherwise specified. The intensity on the ground was roughly four times the air readings. These numbers should be considered with caution since they were taken under very adverse conditions and also are, in some cases, interpolated.

Residual Contamination Levels

Place	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

(g) Readings taken on the ground.

(a) Readings taken at 150 ft altitude.

(b) Readings taken at 500 ft altitude.

(c) Readings taken at 1,500 ft altitude.

[redacted]

IX. PRELIMINARY RESULTS OF MIKE EXPERIMENTAL PROJECTS(3)

Preliminary reports were written by project officers in order to give an early over-all picture of the recovery and data situation after Mike Shot. The data which have been extracted from these preliminary reports must be treated with a jaundiced eye, since most of them have been determined by very cursory investigation of the records. However, some of the numbers - for instance the ball-of-fire yield and the time from [redacted] detonation to the beginning of the thermonuclear reaction - should be fairly close to the final values. In many cases only statements about recovery can be made, since it may take several months to reduce the data.

PROGRAM 1 - RADIOCHEMISTRY

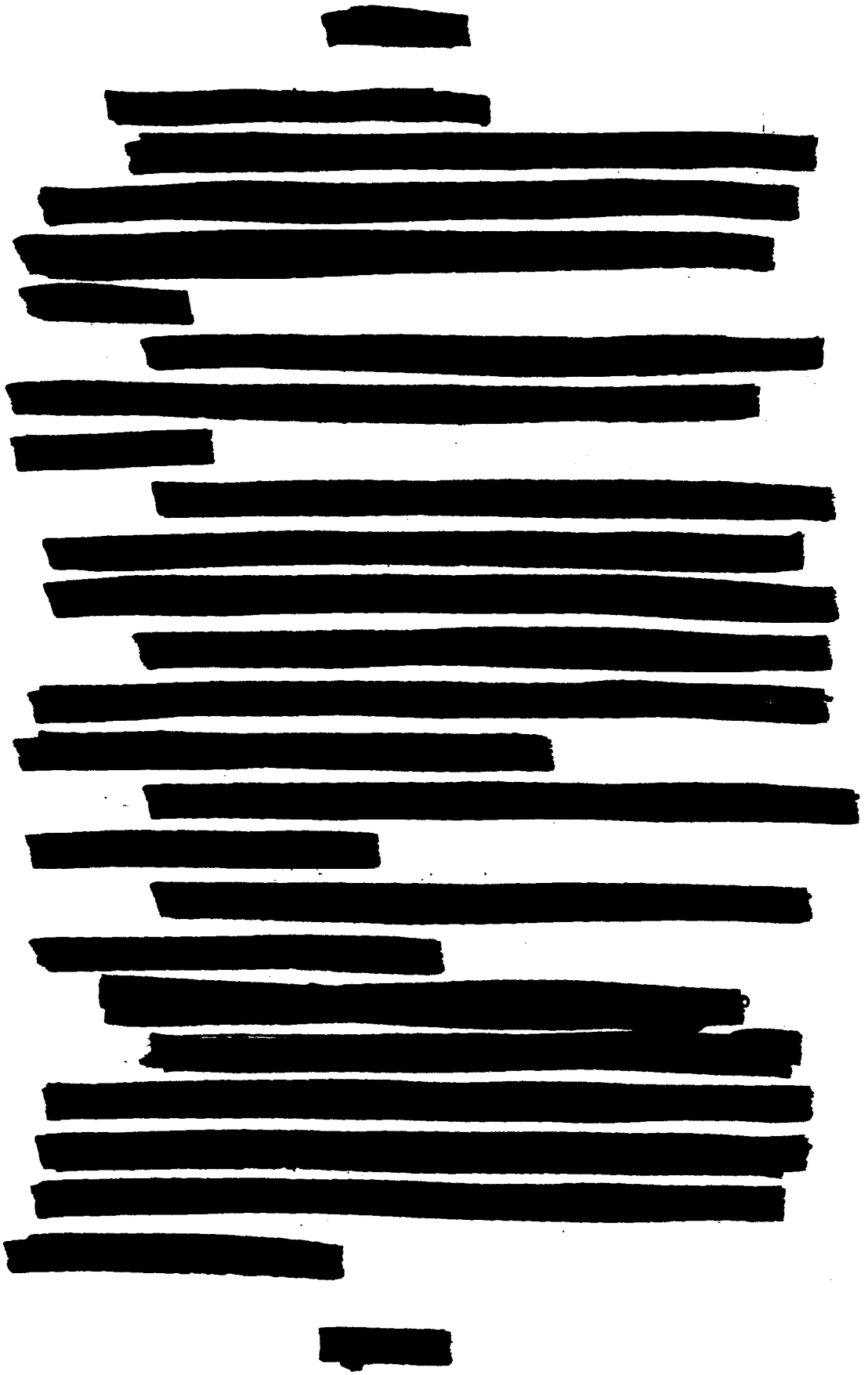
The purpose of Program 1 was to determine, by radiochemical methods, the yield of the Mike device and whether or not thermonuclear burning took place and propagated. Thus, Projects 1.1 and 1.2 were concerned with the analysis of radiochemical samples and Project 1.3 with the collection of those samples.

Projects 1.1 and 1.2-Summary of Preliminary Radiochemical Results

1. Fission Yield

[redacted]

(3) "Mike Shot Cursory Reports on Experimental Programs", J-14928, dtd 8 November 1952 [redacted]



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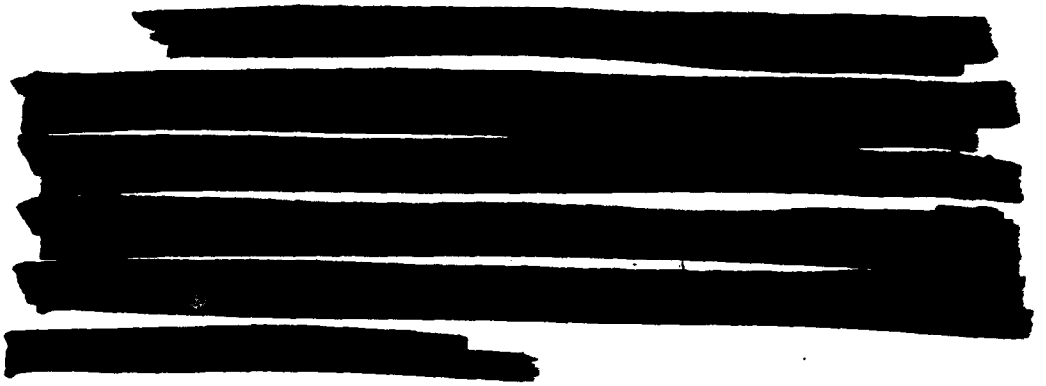

Project 1.3 - Cloud Sampling on Mike Shot

Twelve samples were obtained by the F-84G aircraft, including the two used for early reconnaissance.

Samples obtained by Red Flight (1M, 2M, 3M), as well as one sample from White Flight (7M), were each approximately the size predicted and were satisfactory for yield determination. Samples 5M and 6M of White Flight and 9M, 10M, 11M, and 12M of Blue Flight were approximately one-third the size of the best four and were satisfactory for the purpose of ratio and detector studies. These samples were from five to ten times smaller than they should have been because of unforeseen operational limitations beyond the control of this project. The two reconnaissance aircraft gave very small samples (15M and 16M) which would be useful for ratio checks.

Sample quality is governed by the capability of penetrating the main body of the cloud. In general, all samples except 11M, 12M, 15M, and 16M, which were taken at radically different altitudes or sections of the cloud, are considered to be as

[redacted]

[redacted]

representative of the cloud as was possible. Excluding the exceptions, the samples were taken at altitudes between 42,000 and 44,000 ft, which was in the region of the junction between the upper toadstool and its stem. Because of formation flying some of the samples should be almost identical, so that the actual spread in the data may not be a true index of the randomness of sampling. By comparison, the excepted samples should afford an insight into the representativeness of the others.

Only Red Flight aircraft approached the planned operational exposures. Failure to attain the planned exposure in the other flights is reflected in the lower sample sizes which they obtained. Red Flight exposures were in the ¾ to 1 roentgen level, White Flight in the 0.5 to 1 roentgen level, and Blue Flight in the 0.2 to 0.4 roentgen level. Because the aircraft were carefully hand-polished by the F-84G personnel, the cockpit background was very much lower than expected. The total radiation exposures were therefore approximately 40% less than had been anticipated. In view of the fact that these aircraft saw radiation intensities in excess of 500 r/hr, the low exposures achieved by Red Flight should be considered a testimony to the skill of its pilots.

Use of the shielded flight clothing by Red Flight apparently gave about a four - to five-fold reduction in radiation exposures.

[redacted]

The effect did not appear to be significant for White Flight, although for Blue Flight there again appeared to be a significant protection. The protection afforded to Red Flight apparently corresponds to evidence that a considerable fraction of the radiation flux in the cloud during Red Flight penetrations may be due to [redacted] This evidence was gained from an analysis of the decay rate of reported peak radiation intensities in the cloud.

The bomb burst formed an upper cloud about 100 miles in diameter with a stem in the center approximately 30 miles in diameter. A white vaporous undercloud was present forming a collar around the stem. It had a diameter about the same as the upper cloud. It was initially tangent to the upper cloud at the juncture of the stem with the upper cloud (45,000 ft) but during the course of the day appeared to subside to about 40,000 ft. Several projecting fingers were present in the neighborhood of the juncture of the stem and upper cloud, and some of the sampling aircraft were directed to sample in this region. Under these circumstances the altitude performance of the aircraft was satisfactory. The maximum altitude attained by any aircraft was 45,000 ft indicated. When such aircraft exist, it would be desirable for very high-yield devices in the future to have about 5,000 ft additional ceiling capability in order to sample well into the main body of the cloud.

[redacted]

[redacted]

Successful sampling requires that the aircraft have a flight time capability long enough to permit radiation exposure to limit the duration of the mission. This condition was true only for Red Flight. The unforeseen operational limitation in flight times, mentioned above, arose because the IFF blips from the sampling aircraft were obscured on the radar equipment in the control B-29 by the cloudy weather which existed at the time of sampling. As a result, the sample control B-36 was directed to fly farther from the main cloud mass than it should have been. Eventually, the details of the cloud were lost to those in the B-36 and the sampling aircraft were required to fly excessively long distances to reach the cloud vicinity. They then had to conduct a cloud search as well as a sampling mission, although the former was to have been the function of the B-36. After sampling, the aircraft then incurred the risk of running very low on fuel by having to return over a great distance to the refueling area. In view of these considerations, the F-84G aircraft in White and Blue Flights did not meet the requirement that they have the capability of spending two hours in the sampling area. Corrective measures were discussed with the Commander, TG 132.4.2, and it is believed that this condition will have been corrected by King Shot.

PROGRAM 2 - PROGRESS OF THE NUCLEAR REACTION

The work of Program 2 was conducted entirely by a branch of the Naval Research Laboratory under the direction of E. H. Krause.

[redacted]

[redacted]

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NRLX Diagnostic Experiments

The data as here presented must be considered as tentative and rather crude since they are the result of a very hasty and rough analysis made in the field.

The following table lists the results as well as an estimate of the errors involved. The errors have been listed sufficiently large to take into account the hastiness of the analysis. The ultimate accuracy of the experiments is considerably better than is given by the numbers in the table.

On the basis of the analysis so far, it appears that all experimental equipment functioned perfectly. Each of the forty-one installed indicators gave a good record.

A complete analysis will, of course, be made and much more complete results and analysis will be presented in a final report.

[redacted]

[redacted]

PROGRAM 2 RESULTS

[redacted]

PROGRAM 3 - SCIENTIFIC PHOTOGRAPHY

Program 3 is made up of those projects concerned with technical photography of the Mike device and its effects. The work was divided among three organizations. Edgerton, Germeshausen and Grier, Inc., were respondible for that photography concerned with large-scale effects, ball-of-fire photography to determine yield, cloud rise and cloud motion, etc. Their work also included photography for the blast program (Prog. 6) and in connection with timing and firing (Prog. 10). Lookout Mountain Laboratory was concerned with

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before and after photographs of the reef where the bomb was detonated. LASL-J-15, under G. Felt and B. Brixner, was concerned with detailed photography of the very early stages in order to tell us about radiation flow down the channel, shock velocity in the steel, etc.

TECHNICAL PHOTOGRAPHY BY EG&G

Project 3.1 - Ball-of-fire Yield

Sixteen Eastman cameras were used: 79% ran properly, 7% lacked velocity markers, and 14% failed to run due to a faulty contactor. The records are of excellent quality; however, the extremely low surface brightness of the fireball at the time of minimum gave rather weak images in this portion of the record. Twelve Rapatronics were used: 17% gave excellent pictures, 50% were usable records but were rather weak, 25% gave no images owing to lack of light in the early stages of fireball growth, and 8% failed entirely because of failure of the mechanical shutter. One Mitchell camera operated 100%, giving good images during the interval of fireball growth. These cameras were located as follows: 5 on Engebi, 2 on the USS Estes, and the remainder on Parry.

Project 3.2 - Cloud Phenomena

Five Mitchell cameras were used, of which 80% performed properly. The failure of the other has not yet been explained. These records document the early stages of fireball rise, and

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the later stages are obscured by natural cloud cover. Two Speed-Graphic cameras were used aboard ship, but also failed to document the rise because of clouds. Two Speed-Graphics and one A-6 movie camera were employed in two aircraft at approximately 70 to 100 miles; it is estimated that these cameras will provide satisfactory photographs, but the films have not yet been processed.

Project 3.5 - Illumination as Function of Time - GR Slit Cameras

Two slit cameras were operated with 100% success. Fifty per cent of the film has been processed.

Project 3.6 - Bhangmeters

Four Bhangmeters were installed on the Estes. Twenty-five per cent triggered but gave incorrect readings (see description, Project 3.1). All four instruments were wet from salt spray.

Project 6.2 - Photography for Air Mass Motion Studies

Fifteen Mitchell cameras were used to photograph mortars and gun bursts for LASL-J-10. One hundred per cent of the cameras operated although the speed was reduced from 100 to 70 frames/sec in the interests of reliability. Approximately 80% of the records contain usable smoke-puff data.

Project 6.4a - Water Wave Motion, Shallow Water (Photographic)

Four cine-Special 16-mm movie cameras were used, and 100% operated. However, only 75% can be considered successful

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since the radiation-protection shelter and mirror on Engebi were damaged at the time of shock arrival. The degree of success of the experiment cannot be estimated until the films are duplicated and projected as movies.

Program 10 - Timing and Firing

Two EG&G scope cameras were used to record the world time of the burst by comparison with WWVH: 100% operation. Two cine-Special movie cameras were used to photograph the television monitors: 100% operation.

PRELIMINARY RESULTS

Certain results have been read from the films; some of these are subject to change as other films are read, and others are final.

1. Yield

Preliminary measurements from one shipborne Eastman camera and from eight Rapatronic plates give the yield as [redacted] The fire-ball growth is regular and the outlines are smooth, so that film-measurement errors are believed to be small.

2. Time to Minimum

The time to the light minimum is [redacted] (from Eastmans).

3. GR-Slit Cameras

One Teller pulse is observed, followed by an interval [redacted] in which our record is completely

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blank. Then there is a slow rise to a peak [redacted] and a gradual decline blanking out before the minimum and reappearing again afterward. We cannot make an accurate determination of minimum time from this record.

4. Mortar and Gun-burst Photography

In addition to the expected mortar puffs and gun bursts, these records show objects identified as birds.

5. World Time

The films show the time as 07 hours - 14 min - 59.4 sec local (Eniwetok time), with an estimated uncertainty of ± 0.2 sec.

6. Television Monitor

The FR light did not go over.

Projects 3.3 and 3.4 - Hotspot Observation and Bomb Case Motion

All equipment operated satisfactory. The records from the Model 100 Sweeping Image Cameras were particularly successful. In most cases two mirrors side by side and observing the same spot were separately resolved.

The length in shakes from the starting time of each spot to the cut-off of the sources by the thermonuclear reaction was measured. [redacted]

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Two Model 7 Framing Cameras were run at approximately 90,000 frames/sec. One of these succeeded in catching a single picture [redacted] The lenses, with fields of view of about 400 ft at the object, were just a little too long to catch the transition to the shock phase before the fireball was too big for the frame.

Project 3.7 - Preliminary Photographic Crater Survey

An RB-50 was especially obtained to perform the photo coverage required for Project 3.7. The first mission to obtain the pre-shot survey was flown 18 October 1952. The aircraft aborted due to an oil leak before reaching the target area. The second mission was flown on 21 October and photographic results were good. The altitudes flown were 2,000 and 5,000 ft. A third mission was flown on 23 October to obtain lower altitude verticals and obliques. After the mission the RB-50 landed at Eniwetok, caught fire and became a total loss. No casualties resulted but all cameras and the photo coverage obtained on the mission were destroyed. A new RB-50 was requested and it arrived at Kwajalein at 0500 on 1 November 1952.

The fourth mission using the RB-50 was scheduled for 1 November. However, due to engine trouble this aircraft did

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not become airborne. The fifth mission was flown on 1 November using one of the three C-54 photo aircraft assigned to Task Unit 9. The aircraft and crew received an excessive amount of radiation. The aerial film was processed and found to be fogged. The mission was unsuccessful. The sixth mission was flown on 2 November using the RB-50. Due to weather and light conditions the photo coverage obtained was unsatisfactory. A seventh mission was flown on 4 November using a C-54 aircraft (the RB-50 was non-flyable due to maintenance). Low clouds and poor light conditions made this mission a failure. The eighth mission was flown on 8 November using the RB-50. This mission was a success. The altitudes flown were 750, 1,500 and 5,000 ft.

Due to the configuration of the target area, only one of the three requirements can be accurately determined by photographic means. This requirement is the exact location of zero point after blast. This point will be determined by comparing pre-shot and post-shot photographs. The quality of the photographic records is good.

PROGRAM 4 - NEUTRON MEASUREMENTS

Program 4 under the direction of C. L. Cowan of LASL, was concerned with the determination of total neutron flux as a function of distance from the bomb and as a function of neutron energy, and with slow neutron intensity as a

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function of time at one position relative to the bomb. While these measurements were designed both to satisfy the DOD requirement of knowing that flux and to help LASL determine the total neutron economy of the bomb, their primary purpose was to measure the above quantities as a function of distance and time in order to assist in analysis of the gadget in the event of a fractional yield. However, enough samples were recovered to supply external neutron information.

Project 4.1 - Slow Neutron Observations

Project 4.2 - High-energy Neutron Observations Threshold Detectors

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There were 47 stations from zero to 2500 yds west of zero along the reef. Only 13 samples from a total of 282 had been recovered, as of the date of the report.

These samples were sent to Los Alamos for counting.

Project 4.4 - Neutron Intensity as a Function of Time

The object of this experiment was to measure slow neutron intensity versus time. The fission catcher camera was used, located at 1300 yds from zero. To date this project has been unable to locate the camera stations.

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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, [redacted] 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

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 permenently for controls. These stations were placed at 100-yd intervals where land was available from 1,500 to 6,000 yds.

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These stations were all nearly totally destroyed, only those at the extreme ranges being recoverable. The stations from 4,500 to 6,000 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

The gamma-ray intensity vs time with a time resolution of 0.1 μsec was recorded at a blockhouse on Ruchi 2,500 yds from ground zero, using a system of scopes with linear sweeps ranging from 3 μsec to 1,000 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 SanIldefonso (1,200 yds), Cochiti (1,800 yds), and Bogombogo (4,300 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 its 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 [redacted]

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Project 5.3 - Gamma-ray Intensity vs Time

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 canisters 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.

A preliminary plot of dose rate versus time for Engebi, Biijiri, Rigili and Runit has been drawn. 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

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ionization chamber sustained 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, 5 mr/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.

Project 5.4a - Fall Out Distribution and Particle Size

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.

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(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, Agawan, 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

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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

(a) Land Stations Within the Atoll

Of the eight land stations, Bogallua, Engebi, Yeiri, Piiroai, 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 Yeiri, Runit, Aniyaanii and Eniwetok the "Blue Boxes" failed to trigger. The Bogallua station was demolished so it can not be determined if that station did trigger.

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(b) 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 jointed 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 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 1/2 miles. These rafts suffered some blast and thermal damage but satisfactory samples were collected.

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(c) 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 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

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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 shackel would have overcome this difficulty and probably assured a greater percentage recovery.

(d) 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 be only 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.

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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.

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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 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 except one of the buoys which on recovery showed measurable fall-out with survey instruments (TIB's), were to the north of a line running east from Eniwetok.

Project 5.4b - Close-in Particulate Cloud and Fall-out Studies

The experiment was essentially as described in the Turquoise Book, except that no extensive attempts were made to sample the cloud near the surface of the ground. The experiment consisted of two parts: (a) fall-out collectors operated from H + 15 minutes until H + 6 hours on twenty-four islands (thirty-two stations), (b) cloud sampling at high altitudes in conjunction with Programs 1 and 7. F-84G aircraft were employed to collect gaseous and particulate samples.

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Particulate samples from (a) and (b) above will be analyzed for activity, article size, and radiochemical content. Relationship between activity and particle size will be determined. Determination of number ratio of active to inert particles will be attempted.

The experiment was successful in that twenty-four of the thirty-two stations installed were in the area of fall-out. Four of these stations (those at Bogallua, Bogonbogo, Ruchi and Bogon) were destroyed, four others did not start due to Blue Box malfunction (those at Rujoru, Aaraanbiru and two at Runit). Fall-out samples were obtained at the following islands: Engebi (2), Muzin, Kirinian, Bokon, Yeiri, Aitsu, Eberiru (2), Aomon, Biijiri, Piiraai, Rigili (2), Eniwetok and Parry.

No data reduction is being conducted in the forward area: only observations are available at this time. The fact that there was considerable liquid as well as solid fall-out is obvious. The solid fall-out consisted of many large particles, some of which were as large as 1/2 inch in diameter. It should be pointed out that small particles would not be visible without a study under the microscope.

PROGRAM 6 - BLAST MEASUREMENTS

Program 6 was set up to study the characteristics of the shock wave due to Mike detonation. Measurements were to

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be made high in the air, on the ground, in deep and shallow water, and in the ground. The measurements were under the over-all direction of E. F. Cox of the Sandia Corporation and F. B. Porzel of LASL.

Projects 6.1, 6.3, 6.5, and 6.7b (Sandia)

Project 6.1 - Pressure vs Time on the Ground

This project concerns pressure-time measurements at different distances and azimuths from zero. The pressure ranges extend from 330 psi expected on Teiteiripucchi to 0.9 psi expected on Parry. The mounting arrangements are basically one of three types:

1. Ground baffles, in which the pressure at grade level is recorded.

2. Seventeen-inch baffles several feet above ground surface and facing parallel to the blast direction, measuring free air pressure.

3. Two gauges to measure face-on pressures. Free air pressures are also obtained from gauges mounted in the pitot tubes.

For all air pressure measurements the Wiancko twisted Bourdon tube gauge, which converts the pressure fluctuations into an amplitude-modulated carrier, was incorporated.

Asymmetry was measured by twenty self-recording indentor gauges; ten placed on Engebi (6103) and ten placed

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on Bogallua (6104) at the same radius from zero. From the two clusters, and the fact that the impulse on the Engebi gauges from the Wiancko pickup near that cluster will be known approximately, it is hoped to calibrate these indentor gauges after recovery, and determine if symmetry existed on these two azimuths.

Project 6.3 - Shockwind, Afterwind, and Sound Velocity

Afterwind and sound velocities were measured at four stations by means of interferometers. Each gauge consists of a double transmitter located centrally between two receivers and aligned at 45° to the blast radius, to reduce flow effects. The transmitters are fed pulses at a 150-cps repetition rate, and the transit time of these pulses to each receiver is measured. The measurements result in triangular waves, the height of which is proportional to the transit time. Knowing the transit distance and time, the afterwind and sound velocity can be computed. The four locations used were Engebi, Muzin, Bokon and Aomon.

Dynamic pressures were measured by means of Wiancko pitot tubes and Sandia-designed "Q" gauges. The pitot tubes are double ended, having Wiancko differential pressure gauges mounted at each end, enabling the measurement of dynamic pressures for positive and negative velocities. The "Q" gauge consists of a tube facing zero inside of

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which a bronze "Lollypop" is mounted as a cantilever beam. Four strain gauges are mounted at the point of maximum bending moment in a four arm bridge configuration. The output of the bridge is a function of the "drag force" on the element. In conjunction with the "Q" gauges, total pressure heads were measured by Keil gauges. The velocity heads were converted to pressure heads by means of tubes facing into and away from the blast radius. The "Q" and pitot tube measurements were made on Engebi, Muzin, Aomon, Bokon and Parry.

Temperatures of the air during the blast phenomena were measured by resistance thermometers at the same locations as the "Q" gauges. The gauge consists of a 0.5-mil wire mounted to the tips of several small probes clustered together and is used in a bridge configuration. The element was shielded from the direct radiation by a metal cover. Changes in the resistance of the element are dependent on air temperature and to some extent to particle velocity.

Project 6.5 - Ground Motion - Seismic Measurements

Earth motions, or, more specifically, earth accelerations were measured at Bogon, Engebi, Muzin, Bokon, Aomon and Parry. For each installation the radial, vertical, and tangential acceleration components were measured utilizing Wiancko accelerometers. The three gauges at

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each installation were placed at an average depth of 17 ft. An effort was made to match the density of the case to the density of the coral. The accelerometer case on Bokon leaked, ruining the three gauges. Since the contractor had removed his drilling equipment, three new gauges were mounted in the shelter as an expedient solution.

Project 6.7b - Underwater Pressures - Along Reef

Four underwater pressure-time measurements were made at depths of approximately 100 ft and at a distance of about one mile off shore on the lagoon side. These were located off the islands of Teiterripucchi, Engebi, Aomon, and Parry. Wiancko twisted Bourdon tube gauges were utilized, being mounted on tripods 10 ft in height to raise them off the lagoon floor.

Sandia's portion of Program 6 was treated as one project and the information was recorded in the nearest one of the 600-series shelters. A tabulation, by shelter, of the channels of information believed usable or believed lost follows:

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Station	Location	Usable Channels	Lost Channels	Time Blue Box
600	Bogon	2 possible	14	OK
601	Engebi	16	1	OK
602	Muzin	10	3	OK
603	Bokonnarappu	5 (2 possible)	8	NG
604	Aomon	8	6	OK
605	Runit	2	0	NG
606	Parry	11	1	NG

This tabulation does not include the 19 out of 20 self-recording indentor gauges which were recovered.

The failure of the recording equipment was the result of several causes. The high humidity in the shelters after sealing them on M - 2 caused the brakes on the magnetic tape reels to swell and lock, and one recorder's tape to stick to the guides. The air shock on the 600 shelter damaged much of the electronic equipment. The air shock at station 603 caused one of the recorders to jam but most of the information was salvaged.

These high humidity problems were not encountered during the test runs as the equipment was warmed up for several hours each day.

Some gauge failures were encountered. All temperature gauge elements were broken by the force of the blast. High

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humidity caused some opens to occur in the strain gauge elements of the "Q" gauges. Sonic interferometer failures were caused by poorly designed weatherproofing of the exposed equipment.

Project 6.2 - Air Mass Motion Studies

The experiment was conducted as outlined in the Turquoise Book with several minor changes. In place of "Blue Boxes", the raft mortars utilized an EG&G radio timing signal for firing. Due to a scarcity of Mitchell cameras, several stations used Bell and Howell cameras (similar to the Mitchell) for photographic coverage. The spatial coordinates of the two gun bursts closest to zero island were changed since there existed a finite probability of fragments falling on the zero island during test firing. The two bursts were relocated at the same horizontal range as the 10,000 - and 11,000 ft bursts and their altitude increased from 5,000 and 6,000 ft to 8,000 and 9,000 ft, respectively.

Camera operation was 100%; mortar firing was 82% (the mortars on Mack and Parry failed to receive the radio firing signal); gun firing was 100%. Total equipment operation was 90%.

An analysis of the 15 films recovered shows that the reef mortars (Stations 620.01 - 620.04) may produce limited

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data since the thermal dust raised on Engebi obscured the mortar puffs at an early time. Of the five raft mortar films, two definitely obtained data on mass motion, one obtained no data, and two are marginal due to prevailing light conditions (plus-X film, rather than microfile, had to be used; resolution is consequently poorer). The mortar film from Parry contains no data. The five films covering the ten gun bursts all contain excellent mass motion data. A summary of the quality of data obtained gives: 47% excellent, 27% good, 13% marginal, and 13% no data.

Project 6.3 - Measurements of Afterwind

The purpose of this experiment was to measure the velocity of the wind produced by the negative phase of the shock wave and the air motion resulting from the rise of the fireball.

A sonic anemometer was used to measure the wind velocity. In this device, two microphones and a pulsed sound source are oriented in such a way that one microphone is located upwind and the other downwind from the sound source. The transit times of the sound pulses between source and microphones are recorded by a camera-oscilloscope recording system. From the transit times, the wind velocity can be deduced.

[redacted]

[redacted]

From four stations which were instrumented in this experiment, three records were obtained which are favorable for analysis. No signals were recorded at the fourth station, although the camera and oscilloscope operated properly; failure to detect sound pulses is believed to be in malfunctioning of the amplifier.

Project 6.4a - Water Wave Motion, Shallow Water (Photographic)

The purpose of this experiment was to observe the motion of water waves in the lagoon near various islands. Cameras were installed by EG&G on Engebi, Rojoa, Runit and Parry. These were 16-mm cameras with 25-mm lenses, operating at 10 frames/sec for a total running time of 10 min. At each location a large raft was moored at 3,000 ft from the camera. An array of five barrels was moored about 1,000 ft from the camera and a pole was placed in shallow water near the beach about 300 ft from the camera. These objects served as markers whose motion can be measured on the film.

All markers survived the shot intact. Those at Engebi were scorched by the thermal radiation. All cameras ran. On Engebi, the mirror on the camera housing, which directs the image downward into the lens, was blown off by the air shock, so that no water wave pictures were obtained. The remaining three original negatives are available only for

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examination of single frames with a hand magnifier. Such examination indicates displacements of a foot or so at Parry and 2 or 3 ft at Runit. Wave arrival at Rojoa has not been detected on the film. Air shock arrival at Rojoa can be seen. On Engebi, where the camera with no mirror was looking overhead, the passage of the cloud-chamber effect can be seen.

Project 6.4b - Sea Waves

The object of this project was to measure the barometric and surface water waves produced by Shot Mike. Commercial recording microbarographs were used to instrument the former; the water waves were to be detected with three types of wave meters in three general locations. Pressure-type remote recording wave meters were designed to accept only the appropriate waves by means of a hydraulic band-pass system and were installed on two seamounts north of ground zero and on islands of Bikini Atoll. Absolute pressure recorders (accepting all pressures) were installed in Eniwetok lagoon. At distant islands, critically damped water level recorders were installed which would accept long period waves. All these instruments were able to cover a fairly wide range of amplitudes which extended to slightly above those predicted on the basis of "best guessing" and extrapolation from previous experiments.

[redacted]

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The waves from Shot Mike proved to be much smaller than expected; within the lagoon they were about one-tenth of those expected; outside none were recorded. (Records from far distant islands have not yet been received.) Microbarograph records were also far below the anticipated.

As an instrumentation program, the project was a success in the sense that all but one of the seven instruments installed were recovered and found to have operated as expected. The fortunate circumstance of a natural seismic sea wave on 4 November provided a nice check on some of the instrumentation and made the project more worth while. Both Eniwetok and Bikini instruments recorded this disturbance (the other instruments having been retrieved previously). A particularly successful aspect of the program was that four instruments were placed on a newly-devised light and inexpensive deep sea mooring which utilized the tops of undersea mountains which rise to within 5,000 ft of the surface. Quite possibly this ability to establish semi-rigid reference points in mid-ocean will turn out to be a real contribution to the study of the oceans. Records recovered were of good quality; the only station lost was a raft which was not recovered from Seamount 26.

The Eniwetok lagoon stations (Runit and Eniwetok Islands) clearly showed the shock wave (equivalent to about 4 ft of water at Runit, 2.5 ft at Eniwetok). At Eniwetok

[redacted]

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the shock wave was followed in 25 min by four waves with a period of about 5 min; the first wave had a through-to-crest height of about 3 ft; the remainder of the waves appeared to be only troughs about 1.5 ft deep. At Runit the shock wave was followed in 15 min by an irregular disturbance, the largest single wave of which was not over 2.5 ft high. As previously stated, no wave records from Mike Shot were obtained at Seamount 72 or at Bikini Atoll; however, small barometric changes were recorded there.

Project 6.7a - Underwater Pressures as a Function of Time and Peak Water Pressure as a Function of Distance

The purpose of this project was to obtain underwater pressure-time records in deep water off the ocean side of the shot island on Mike Shot. To accomplish this purpose, instrumentation was completed on three types of underwater pressure measuring devices. The Wiancko system consisted of a variable reluctance pressure pickup of the twisted Bourdon tube type modified for underwater operation and employing oscillographic recording. The Horizons system consisted of barium titanate pressure pickups employing magnetic tape recording. The NRL telemetering system used the output signals from the Wiancko gauges and transmitted them via aircraft relay to a remote recording station aboard the Task Force vessel. The instrumentation was engineered to fit

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in a shock-mounted cage inside a First Class Standard can buoy. The can buoy was equipped with battery power supply, a set of stuffing tubes for the gauge cables, and a lead box shield for the oscillographic recording. Each buoy was also equipped with a command receiver to operate the sequence of events by remote control from the nearby aircraft. There was a total of four buoys equipped as follows:

Buoy No. 1 - Wiancko self-recording system

Buoy No. 2 - Horizons self-recording system

Buoy No. 3 - Wiancko self-recording system and NRL telemetering system

Buoy No. 4 - Wiancko self-recording system and NRL telemetering system

These instrument cans were to be positioned on the ocean side of the shot island, as follows:

No. 1 - at 6,000 ft from ground zero

No. 2 and 3 - at 9,000 ft from ground zero

No. 4 - at 12,000 ft from ground zero

The project succeeded in getting three buoys on station before Mike Shot.

After Mike Shot the recovery party arrived at the buoy stations on M + 3 and found nothing afloat: the reefs were scanned thoroughly but nothing was discovered. This left two possibilities: either the three instrument cans and twelve spherical floats were sunk at the time of the

[redacted]

[redacted]

Mike Shot, or they parted their mooring and drifted out to sea. TG 132.3 has been notified of the latter possibility and requested to initiate air and sea search.

At M + 4 days, word was received that two cans had been sighted at sea and a ship was enroute to recover them. When recovered, these proved to be floatation buoys and not recording cans.

There is some evidence that telemetered records were obtained. This must await the developing of oscillograph and 35-mm film records, which will not be done in the forward area. However, the usefulness of these records is uncertain due to electronic problems and failure of radio voice count on the USS Curtiss at M - 10 sec. These records comprised about 20% of total records which were to be obtained.

Project 6.7c - Accoustic Pressure Waves in Water

The purpose of this project was to observe the propagation in deep water of acoustic signals generated by a nuclear detonation. As was demonstrated during Operation Greenhouse, this signal can be used as a means of arriving at a rough estimate of yield. It is believed that equal or greater success will be realized in obtaining yield numbers from the Mike and King shots of Operation Ivy.

[redacted]

[redacted]

The acoustic signals generated are detected and recorded at several SOFAR (Sound Fixing and Ranging) stations in the Pacific and Atlantic Ocean areas. The signals are propagated in a water layer which is approximately 350 fathoms under the ocean surface in the Pacific and 700 fathoms under the ocean surface in the Atlantic.

Successful records were definitely obtained from Mike Shot at Pt. Sur and Pt. Arena in the Pacific area.

Although the data have not yet been reduced, preliminary indications are that the maximum energy received was apparently concentrated at a lower frequency than was the case at Operation Greenhouse.

Project 6.9 - Air Density Measurements using the Beta Densitometer

The purpose of beta densitometer instrumentation at Mike Shot was primarily to measure material density near the ground surface as a function of time and, secondarily, to test improvements in the densitometers that functioned successfully at Operation Tumbler.

Densitometers were located at four stations:

Sta No.	Site	Distance from Ground Zero
690.01	Engebi	19,000 ft
690.02	Kirinian	23,000 ft
690.03	Bokon	31,000 ft
690.04	Aomon	48,000 ft

[redacted]

[redacted]

The densitometer at Station 690.01 failed, since the camera did not operate. The densitometer at Station 690.02 worked successfully and gave results. Densitometers at Stations 690.03 and 690.04 gave no results. Cameras operated but beta signal trace did not appear until a few seconds before the end of the film record. The films indicate a possibility of EG&G relays operating in reverse sequence, i.e., the - 5 sec relay operating at - 1 min, and - 1 min relay at - 5 sec. Proper cable leads were connected to proper relays. All densitometers (including Station 690.02) were identical in circuitry and in connections to the EG&G relays. All equipment was checked for proper operation including internal relays and leads to EG&G relays. In the field all densitometers were correctly connected.

Arrival time of blast at Station 690.02 was 9.5 sec after zero. Maximum density measured was 8.8 gms/liter ≈ 7.3 times normal density, occurring about 2.2 sec after blast arrival.

In general, during the period from 0.5 sec after blast arrival to 3.0 sec after arrival, the density varies randomly from about 2.5 to 3.5 times normal. This indicates considerable loading of the air by dust, pebbles, coral, and other debris.

[redacted]

Project 6.10 - Free Air Pressure as a Function of Time (manned aircraft)

The purpose of this project is to determine the blast effect on a manned aircraft in the vicinity of a nuclear explosion. To accomplish the mission an instrumented B-36D and B-47B were positioned at pre-determined points in space near the explosion. These aircraft recorded the blast effect on the aircraft structure. The B-36D was instrumented with strain gauges, accelerometers, and a Cook recorder. Eighteen channels of blast measurements were obtained. The B-47B recorded six channels of blast data.

Useful data were obtained on 100% of the channels of the B-36D. Ninety per cent of the recordings are of good quality. There were no useful data recorded on the B-47B. The aircraft was apparently too far out from the pre-determined position and the oscillograph ran out of paper before the shock arrival. Shock arrival was computed as 136 - 159 sec depending on yield; recorder ran out of paper 165 sec after time zero.

Preliminary indications follow:

1. Horizontal tail bending moment for the B-36D was approximately 62% of limit.

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2. Bending moments in the wing due to the gust were very low, as expected.

3. The B-47B aircraft was not in position, apparently, since very few data were obtained.

Project 6.11 - Free Air Pressure as a Function of Time, utilizing Parachute-suspended Canisters

Of the twelve parachute-borne canisters deployed during Mike Shot, ten canisters functioned properly in all respects. The radio telemetry stations on the USS Oakhill recorded all four sub-carrier channels from each of the ten canisters. Measurements of ambient pressure, differential pressure, and thermal flux were successfully recorded. Aircraft positioning and canister positioning in space and time were very successful. Two canisters had a free fall due to parachute failure and experienced impact prior to H time. However, each position in the canister array was duplicated by two canisters so that all six positions in the array were recorded. Therefore, in reference to the information obtained for each array position, the recordings indicate that 100% data was obtained. The quality of the recordings was excellent for each canister. Thermal measurements were obtained from the five canisters nearest ground zero. The thermal measurements from the five canisters most distant from ground zero indicated that thermal instrumentation was not adequately sensitive for the thermal radiation existing at that distance.

[redacted]

[redacted]

The only quantitative results available at the present time are the arrival times of the blast wave to the canisters.

PROGRAM 7 - LONG RANGE DETECTION

The basic objectives of this program were directed toward obtaining calibration data and in developing specialized equipment and techniques for the long range detection of nuclear explosions or events.

The Long Range Detection System consists of several diversified techniques covering the fields of electromagnetic effects, airborne low-frequency sound, seismic wave propagation, and the distant transmission of fireball light. Further, the continuing evaluation of airborne bomb debris requires the analysis of close-in bomb debris from known US nuclear detonations.

The objectives of this program were met by the Program 7 projects which participated in this operation.

Project 7.1 - Electromagnetic Effects from Nuclear Explosions

Of the 11 stations operating, six stations are reported to have received signals, three stations report questionable signals, and two stations have not reported.

These signals (pulses) will have to be carefully analyzed to determine their significance in fulfilling the objectives projected for this program.

[redacted]

[redacted]

Project 7.2 - Airborne Low-frequency Sound from Atomic Explosions

It is reported from Washington, D.C., that all stations received positive signals.

Detailed data covering the amplitude, frequency, duration, and apparent velocity of the incoming wave along with the azimuthal path will be determined by detailed study of the records obtained from recorded signal readings.

Project 7.3 - Calibration Analysis of Close-in A-Bomb Debris

The F-84 and B-29 sampling aircraft missions were considered successful from a sample quantity point of view. The quality of the filter (solid) and snap (gaseous and particulate) samples can be determined only after completion of radiochemical analyses in the various laboratories in the ZI. According to an estimate by R. Spence of LASL, it appears that filter samples may contain high quantities of natural uranium carried in the coral and sea water; if this condition was found in the higher altitude sampling aircraft, it will probably be more pronounced in the B-29 or lower altitude sampling aircraft. High uranium background in the samples may interfere with the projected analysis for uranium and all its isotopes. This should not interfere with the fission product analysis to any appreciable degree.

[redacted]

[redacted]

All filter samples have been successfully couriered to the ZI and are in the hands of the respective laboratories. Snap samples (gaseous) were obtained from nine F-84 aircraft. These were successfully transferred to G-1 gas bottles and shipped to the ZI for analysis.

In addition residual tritium oxide present as water vapor or condensed water in the snap sample polyethylene bag was removed by flushing the degassed bag with super dry nitrogen and passing the flushing through a series of liquid nitrogen traps to freeze out any tritium oxide that might have been present as water vapor or condensed water in the bag. Control tests of moisture removal from these bags indicated about a 90% yield. Of three bags processed, two indicated about 2 ml residual moisture in the bag after degassing and the third indicated an unknown but probably a negligible quantity of water. The bags (three) will eventually be burned in a ZI laboratory to complete the material balances of tritium and tritium oxide in the snap sample and may ultimately be related to Kr^{85} measurements. All samples have been successfully couriered to the ZI for processing.

In addition, three B-31 gas samples were obtained close in and three Humidry samples from two B-29 aircraft. C^{14}, A^{37}, H^3, T_2O and Kr^{85} will be analyzed from the B-31 samples and T_2O will be sought in the positive Humidry samples.

[redacted]

[redacted]

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 analysis. All the above samples are now in ZI laboratories and under processing.

Project 7.4 - Propagation of Seismic Waves

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

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.

[redacted]

[redacted]

Project 7.6 - Detection of Fireball Light at Distances

No results of this program are available at this time. Measurements from "Saltshaker" Flight No. 1 flying over Kwajalein will probably be negative due to th. heavy cloud cover between zero point and location of the aircraft. Ground measurements at Kwajalein are also questioned because of low and heavy cloud cover and smoke interference from F-84 JATO during take-off of these aircraft.

Film records of these measurements, however, have not been developed and specific results of this program will be reported upon analysis of the developed film.

PROGRAM 8 - THERMAL RADIATION MEASUREMENTS

The purposes of Program 8 were to measure those characteristics of the light from Mike Shot available from a distance and to determine the total thermal flux emitted in the visible region. Thus, H. Stewart of the Naval Research Laboratory had several well-instrumented stations on the ground, and Lt Col Rodney Nudenberg (USAF) had two manned aircraft as observing stations.

Project 8.1 - Integral Thermal Radiation

As a very preliminary "guess", the thermal energy radiated by the bomb was given by NRL as [redacted]

Recovery of the black ball instruments at Noah, Kirinian, Bokon, Yeiri, and Biijiri was completed. The

[redacted]

[redacted]

Noah instrument was damaged by the shock and no record was obtained. The Biijiri instrument failed of its own accord. The other instruments worked properly: their deflections are about as expected, but the data have not been reduced.

Project 8.2 - Thermal Intensity as a Function of Time

At Biijiri the thermal power was measured as a function of time using a bolometer-chopper system into the recorder of which was introduced a zero signal from a fiducial marker. A plot of the power incident at Biijiri as a function of time was obtained and the incident energy calculated as [redacted] Correction for atmospheric transmission and inverse-square law sets a value for the thermal energy radiated between [redacted] (where scattering correction for 30° diameter field of view is used) and [redacted] (where no scattering correction is made). Good records were obtained on two machines at Engebi but these data have not been reduced.

At Engebi one of the three photocell systems gave a readable trace of Teller light from the fusion phase of the explosion. All delays taken into account, the second Teller light appears to have come at [redacted]

[redacted]

[redacted]

Project 8.3 - Spectroscopy

The Baird spectrograph was located at the 100-ft level of the photo tower on Parry Island. It was set to cover the region 3100 Å to 5100 Å. A quartz blast shutter was closed at about + 15 μsec. One line of the Teller spectrum was recorded, being tentatively identified as the 4236 Å line of the first negative series of N_2^+. Since a 10 ft focal length mirror was used to form an image of the Teller zone on the slit of the spectrograph, no greater exposure was possible without increasing the exposure time. On this plate, no continuum appears and it may be concluded that bomb light in the interval 0 - 15 μsec was weak.

The Jarral-Ash spectrograph was set to cover the region 4000 - 7700 Å with resolution of 5.1 Å/min and the region 2200 - 4100 Å with resolution 2.5 Å/min. Spectrum of the bomb extends from 3200 Å to 7700 Å.

The spectrum consists of a continuum almost the whole way. It is predominantly strong in the red end from about 5000 to 7500 Å. It is essentially the same as the sky spectrum in this region, the terrestrial absorption of water and oxygen being the prominent factor. Small differences in band appearance here are probably due merely to difference in path length.

[redacted]

[redacted]

Below about 5000 Å the patterns of molecular absorption bands are not found in the spectrum of the sun or sky. Molecules to be expected are NO_2 and HNO_2, N_2^+ and N_2 together with O_2, excited vibrationally. It thus seems that the molecules responsible for these absorptions are prepared or excited beforehand by action resulting from the bomb. Exact identifications must remain for further study; N_2 and NO_2 seem quite probable. HNO_2 falls in a region of strong take-out and its existence is difficult to prove.

As the cursory examination at present shows, there is no evidence of atomic absorption lines anywhere. For example, iron and hydrogen are not present. It seems quite certain that the spectrum at the very end (between about 3200 Å and 3350 Å) is one of emission, but because of the complex and ragged appearance, it remains to be seen if exact measurements here can provide complete answers.

A cine spectrograph was operated at Biijiri. The Teller spectrum is quite similar to that observed at Greenhouse and Nevada, and is almost certainly due to the second positive series of N_2 and the first negative of N_2^+. HNO_2 and NO_2 show in the earliest spectra.

[redacted]

[redacted]

At Engebi a strip spectrograph operated properly and a good film was obtained. However, no timing marks show, but since Teller lines appear faintly and the time of first maximum is easily measured on the film, a reasonable time scale with a good zero can be established. The ball of fire drifted out of the field of view before second maximum.

A 5000-frame/sec spectrograph at Engebi worked perfectly. [redacted]

Project 8.4 - Atmospheric Transmission

The operational transmissometer functioned properly. The transmission from the shot building to the photo tower at Parry was 13% at shot time. The transmission from the shot building to the photo building on Bogallua was 75% at shot time.

Project 8.5 - Thermal Radiation as a Function of Time in Free Air, Utilizing Manned Aircraft

The purpose of the project was to determine the thermal inputs and effects on an aircraft in the vicinity of a nuclear explosion. To accomplish the mission, an instrumented B-36D and B-47B were positioned at pre-determined points

[redacted]

[redacted]

in space near the explosion. These aircraft recorded the thermal inputs and thermal effects on the aircraft. The B-36D recorded 36 channels of thermal response. Eighteen channels of thermal information were recorded by the B-47B.

Useful data were obtained on 100% of the channels on both the B-36D and the B-47B. Ninety per cent of the recordings are of good quality. It was apprent from the analysis of the thermal flux readings that the B-47B was not tail-to at time zero.

The left wing access door of the B-36D aircraft experienced a temperature rise of 93° F. Thickness of aluminum was 0.025 inch.

Attenuation measurements were not completely satisfactory and yielded very little data. The radio synchronizing link was not functioning. The source was partially obscured by clouds.

The B-47B aircraft was apparently not in position.

No temp-tape data were obtained since the temperature rise was not large enough to melt the metal fuse with the lowest melting point.

[redacted]

It should be noted that the Mike drone on

[redacted]

[redacted]

Greenhouse received approximately [redacted]

PROGRAM 9 - ELECTROMAGNETIC PHENOMENA

Program 9, under the direction of Col L. H. Stanford, was concerned with the measurement of various electromagnetic phenomena associated with the nuclear event. Measurements of electromagnetic signals were made by C. L. Cowan of LASL. Specific interest was devoted by him to evaluating the interval between signals received from the two fission events. Ionosphere effects were measured for the Signal Corps Engineering Laboratories by C. M. Crenshaw, and electromagnetic radiation throughout the radio spectrum by P. Brown for the Evans Signal Laboratory. In addition, the Wright Air Development Center used radar scopes and Bhangmeters installed in effects aircraft to continue their evaluation of these techniques as usable tools for indirect bomb damage assessment.

Project 9.1 - Electromagnetic Signals

The purpose of Project 9.1 was to try to determine, by means of the well-known electromagnetic signals from an atomic bomb, the time between [redacted] and the beginning of the thermonuclear reaction. Several oscilloscopes with 20 μsec sweeps were driven by a loop antenna. The oscilloscopes all operated properly.

[redacted]

[redacted]

A rough measurement of the time interval is [redacted] Since the phenomena causing the electromagnetic signals are not well understood, it is not possible to put an appropriate probable error on this measurement. It might be expected that such a time interval measured thus would be somewhat longer than the true interval by [redacted]

Project 9.2 - Effects on the Ionosphere with Respect to the Propagation of Radio Waves

The following tests were scheduled on this project. These differ only in detail from those outlined in the Turquoise Book.

1. Ionosphere Soundings

A C-3 ionospheric recorder to take continuous recordings from before the shot to H + 1 hr and intermittently thereafter for four hours or longer if conditions warranted, was located at Bikini.

2. Reception of Continuous Wave (CW) Radio Signals

A P2V plane, flying in ellipses at an altitude of 1100 ft, 200 miles west of Eniwetok, broadcast a continuous wave signal to be detected at Bikini. The path was such that the midpoint of the path was above Mike Shot. To prevent interference with other data, the transmitter was cut off at shot time.

[redacted]

[redacted]

3. Interference with Communication Circuits

The AACS was requested to transmit standard teletype messages on the Guam-to-Kwajalein and on the Guam-to-Hickam circuits continuously from H - 30 min to H + 4 hrs and send a carbon copy of the transmitted and received messages to the project officer. In addition, this traffic would be intercepted at Bikini, if possible.

In general, no results are available on this test, as forward area data reduction is not feasible. However, the plane mentioned above, contacted Bikini shortly after H + 2 hrs, thus indicating no long time disruption of the ionosphere.

Project 9.3 - Measurement of Effects of an Atomic Explosion on Radio Propagation

The experiment as conducted was essentially the same as that described in the Turquoise Book. Station locations, however, were changed as follows:

1. On-Site

One station located on Parry Island. The station contemplated for Runit was not considered necessary inasmuch as essentially line-of-sight intercepts on Parry Island are obtainable from Mike and King Shots. No data were obtained due to failure to receive a - 15 sec time signal.

[redacted]

[redacted]

2. Off-Site

Receiving stations operating on optimum ground and ionosphere propagation frequencies located as follows:

(1) Bikini

(2) Okinawa

(3) Oahu, T. H.

(4) California

(5) New Jersey

The data obtained from Bikini indicated definite reception of an electromagnetic pulse of energy at the time of the Mike Shot. The pulse was received on 20 KC (general propagation) and 4.215 MC (ionospheric propagation). No results had been received from other off-site stations at the time of this report. Photographic reduction of data must be made before quantitative data can be presented regarding amplitude vs frequency.

Project 9.4 - Evaluation of Indirect Bomb Damage Assessment Techniques

The purpose of the IBDA program is to determine the capability of the Air Force in the detection of the detonation of a thermonuclear device by radio with particular emphasis on the location of ground zero.

Instrumentation consisted of using three aircraft, each equipped with radio set AN/APS-23, namely, one B-36D,

[redacted]

[redacted]

No. 2653, one B-47B, No. 037, and one B-50D, No. 169. The B-36D was located at a slant range of approximately 15 nautical miles from ground zero, while the B-47B and the B-50D were located at 12 nautical miles and 45 nautical miles, respectively. All radar sets were looking toward ground zero at zero time.

The degree of success of the IBDA is estimated at 100%. Film exposed on this mission has been processed and shows the fireball growth and the passage of the shock wave from breakaway until reaching the airplanes. All radar operators witnessed the fireball growth and cloud rise. Approximately 100 ft of 35mm motion picture film were recovered.

PROGRAM 10 - TIMING AND FIRING

Program 10 was set up under the direction of H. E. Grier of EG&G to furnish timing signals for all experimenters, arming and firing signals to the X-unit, and to telemeter vital information to the control room on the USS Estes.

The master timing equipment was located on the shot island near the zero point. Radio controls were used to give out manually-started signals and to start the sequence timer. This same radio system could also be used to stop the shot at any time before zero time. The following signals were sent out by wires to the various experimenters: [redacted]

[redacted]

-30 min	-30 sec
-15 min	-15 sec
- 5 min	- 5 sec
- 1 min	- 1 sec

The earliest signal was sent out manually and all later signals by cam-operated switches on a sequence timer. This timer was manually started at the proper time before the - 15 min signal was due, and ran through its cycle automatically. To provide accurate timing, all timers and clocks used in the timing system were driven from a standard 60-cycle power supply.

In addition to the wired timing circuits, one signal (-5 sec) was also sent out by radio to stations on rafts in the lagoon. To provide zero signals, photoelectric "blue boxes" triggered by the fast rise of the bomb light were used. Due to the low initial intensity and slow rise time of later light, a considerable number of blue boxes did not operate.

A safety timer was used in the arming circuit which held the circuit open until several hours after the firing party had left the island.

A "no-go" interlock system was connected in the firing circuit. This system was to stop the shot unless the following conditions existed:

[redacted]

[redacted]

All timing relays closed

X-unit voltage OK

Program 2 scope cameras and power supplies ready

Program 3 hot-spot and case-motion cameras ready

Light transmission between Elugelab and Parry above 0.25%

Light transmission between Elugelab and Bogallua above 20%

Two independent television channels between the shot island and the ship were used for telemetering. The two cameras were focused on identical indicator panels.

PROGRAM 11 - PRELIMINARY GEOPHYSICAL SURVEY OF THE TEST AREA

Project 11.4 - Seismic Refraction Survey

This project, the field work of which is not yet completed, in general is being carried out as described in the Turquoise Book. Some changes have been introduced, however. One of the Scripps vessels encountered supply problems and was delayed in leaving the United States. Commander, Task Group 132.3, kindly made the ATF 85, LIPAN, available as a listening vessel. She is not equipped for listening outside the lagoon, but it has been possible to accomplish a large part of the work. The deep-water phase will be consummated following the arrival of the second Scripps vessel, the Baird.

[redacted]